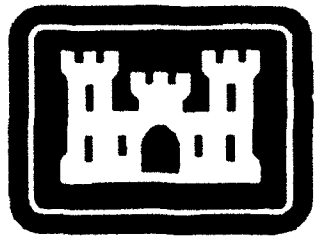

REPORT OF THE USACE

DESIGN QUALITY TASK FORCE

29 January 1993

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13. ABSTRACT *(Maximum 200 words)*

The Design Quality Task Force (DQTF) was formed in November 1991 to improve the quality of design products in the U.S. Army Corps of Engineers (USACE). Quality was defined as meeting all customer expectations with respect to three key components: **Technical Completeness**, **Budget** (Cost), and **Schedule** (Time). These three components must be kept in balance. The task force set up four subgroups--Customer Survey, Policies and Procedures, Production Tools, and Work Force. The Engineer Strategic Studies Center (ESSC) conducted the survey of all district organizations to establish a basis for assessing the state of design quality. Survey findings show the areas that need the greatest improvement are Delivering *Products within Budget, Delivering Products on Schedule,* and *Being More Cost Effective.* Recommendations centered on overall Project Quality and functional Product Quality, a Dual-Career Track for retaining technical specialists, use of the Project/Technical Management Team roles to apply the principles of process improvement, and expansion of Design Partnering.

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EXECUTIVE SUMMARY

INTRODUCTION

In November 1991, the Design Quality Task Force (DQTF) set out to identify problems and recommend solutions for maintaining and improving the quality of USACE design products. This is essential if USACE is to continue meeting its customers' needs and maintaining its purpose for being in business. While the primary focus is on the internal workings of the Engineering Divisions, the observations and findings apply corporately--we want USACE to be **a highly effective and efficient organization**. The work of the task force was essentially completed prior to publication of *Engineer Regulation 5-7-1(FR), Project Management*, dated 9 Oct 92, and the reorganization announcement. The report does not directly address any issues regarding reorganization, but the recommendations are equally applicable to the future USACE, regardless of how it is structured. The roles and responsibilities of the Project Management/Technical Management Team as defined in ER 5-7-1(FR) are a key element in our recommendation for improving quality throughout USACE. The DQTF believes the implementation of its recommendations will greatly contribute to the success of the USACE endeavor in both of the initiatives and will help the Corps remain a viable and competitive organization that is capable of responding to the nation's needs.

BACKGROUND

> *There is a concern among the technical staff that the Corps' design products in the future may be of lower quality than they have been to date. . . . Changes within the past few years in the organization of the Corps of Engineers have had considerable impact on the agency's traditional way of planning, designing, and constructing the Civil Works projects. While these changes are aimed for completing projects on time and within budget, design quality, which has been the Corps' hallmark, seems to have been overlooked.*[1]

The above quote was based on the results of an informal survey of engineering division personnel conducted in early 1991. Section chiefs and senior technical experts in their fields responded to the survey, and 83 percent of these respondents said there is a disproportionate emphasis on schedule and cost that is affecting product completeness. They also said that the trend for the production of quality design is **declining**. This trend is ominous because the consequences of poor design become evident to customers only after projects are finished. Customers rely on USACE to control its overall project production--from initial project development through planning, design, construction, and operations. They expect USACE to deliver a **complete** project **on schedule** and **within budget**. If the finished project has design defects and does not function as expected, USACE has failed in the eyes of its customers and the nation.

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[1] "Maintaining Design Quality in the Corps of Engineers," Presentation by G. Ray Navidi, Chief of Design Branch, Huntington District, to 1991 Chiefs of Engineering Divisions Conference in San Diego, California.

The 1991 survey of Engineering Division personnel identified potentially serious problems with producing quality designs. The continuation of a declining level of quality would lead to customer dissatisfaction and fewer business opportunities for USACE. Therefore, as a first step in addressing these concerns, Mr. Herbert H. Kennon, Deputy Director of Civil Works, formed the DQTF to examine the erosion of design quality. The DQTF was staffed to identify and examine the USACE engineering system's accountability mechanisms that ensure products are on schedule and within budget, and reflect quality and completeness. The DQTF recommendations were reviewed by a Senior Advisory Group that represented headquarters and field elements.

METHODOLOGY

The DQTF embarked on a number of tasks: conducted a survey of Engineering Divisions' internal customers (Construction, Program/Project Management (PPM), Planning, and Operations) to determine how well Engineering is doing its job and what improvements are needed; solicited input from Design Branch chiefs and from journeyman designers; reviewed current regulations, policies, and procedures governing Engineering and Design; collected data on the turnover of Structural Engineering personnel; and consolidated these data into a set of recommendations and a report.

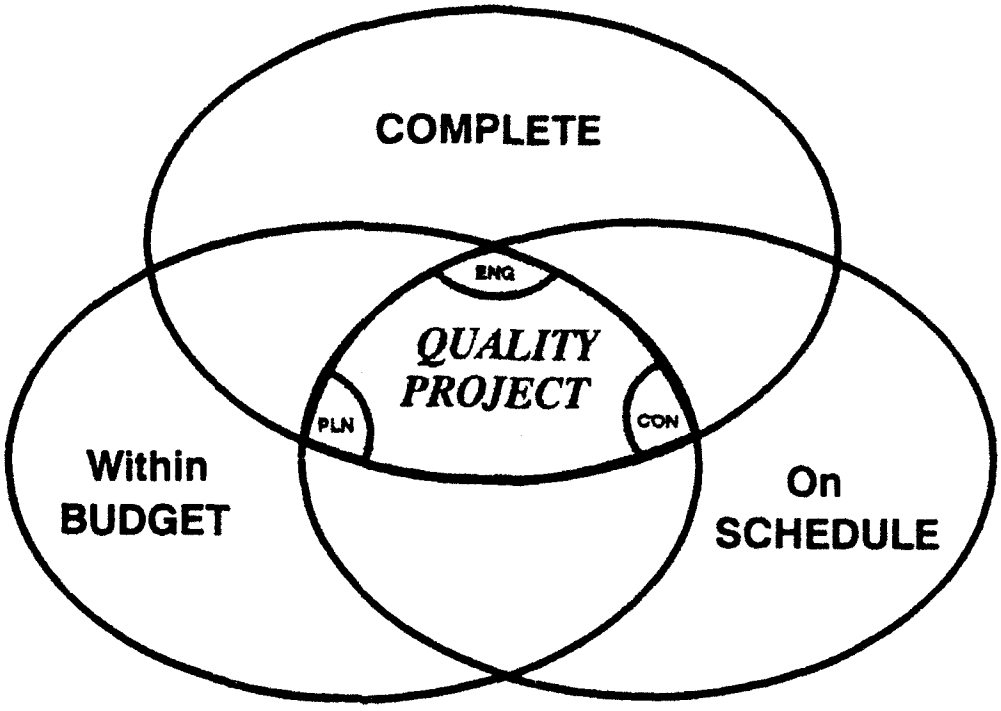
The Engineer Strategic Studies Center (ESSC) conducted a Design Quality Gap Survey of Engineering Divisions' internal customers as a key part of the DQTF effort. There were 1,231 survey responses (the ESSC Survey was simultaneously given to personnel in the Engineering Divisions). The internal customers rated the "**Importance**" and "**Level Today**" of Engineering's performance in 25 areas, and expressed their priorities of areas needing the most attention by the Engineering Division in order to improve quality in its products.

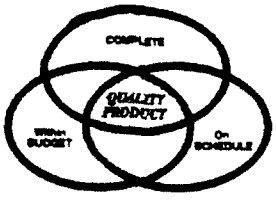
The internal customer survey results reinforce the importance of **Quality Design** and also the criticality of meeting **Schedule** and **Budget** goals. Schedule and cost are the leading concerns of most functional groups. The DQTF agrees that these are essential components of quality products. Construction identified "complete plans and specifications" as its most important requirement. Planning identified "cost effectiveness of small projects" as one of its highest priorities. These responses illustrate that technical performance is also a critical need of Engineering's internal customers. The ESSC customer survey results are being published in an Engineer Pamphlet.

COMPONENTS OF QUALITY

Quality is defined by the Chief of Engineers as **conformance to requirements (i.e., meeting the expectations or properly developed requirements of the customer)**. Customers certainly want their project delivered on time and within budget, but they also expect a project that is functional (meets requirements), aesthetically pleasing, technically correct, efficient, and reliable (i.e., complete). To ensure customer satisfaction, USACE must produce a **QUALITY PROJECT** that results from integrating and balancing three primary components: **Complete**, **Within Budget** (Cost), and **On Schedule** (Time). Each functional element must also balance these same three components to produce quality products. Note that all of the individual functional quality products must fit within the overall **Quality Project** area for USACE to deliver quality projects to customers.

Concept of Project and Product Quality in USACE





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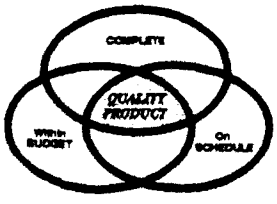

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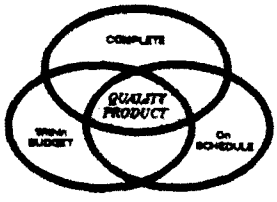

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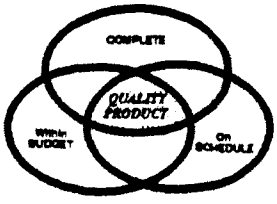
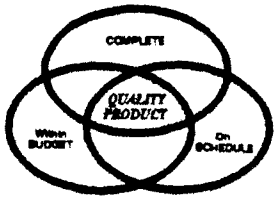


Real Estate



Logistics - Other

STATE OF USACE ENGINEERING PRODUCT QUALITY

What has the DQTF discovered about these three ingredients of **quality products**? For the past several years, the perception in the field was that the corporate emphasis of USACE has been on two of the quality components--**Within Budget** and **On Schedule**. Data from Engineering's internal customers reinforce this perception. There is tremendous energy focused within Engineering and throughout USACE toward achieving budget and schedule goals because these are necessary ingredients of **quality products**. However, the third essential component--that the products be **Complete**--has received little, or subordinated, emphasis, although it is equally important.

Since 1988 with emphasis on Life Cycle Project Management (Total Project), the premise has been that completeness is automatic and that each project (and all functional products) will be up to the usual USACE standard of quality. The DQTF has found that this premise may be incorrect. Maintaining the proper balance, understanding the impacts, and making the proper trade-offs between cost, time, and completeness (the three necessary and competing components of quality projects and products) are difficult and continuing challenges.

Overall, Engineering is not performing to the expectations of its internal customers. The level of dissatisfaction from its internal customers was expressed in issues such as *Inability to Deliver Products on Schedule* for Planning and Operations, *Delivering Products Within Budget* for PPM, and *Delivering Complete Plans and Specifications* for Construction.

The DQTF identified the following areas that influence the production of quality products: increasing demand on the technical staff to do administrative work; changing priorities among multiple duties; constant diversions such as spending time on unscheduled activities; low grade structure for designers; and the most serious and potentially devastating problem--**loss** of experienced designers.

LOSS OF TECHNICAL EXPERTISE

Experienced designers are of premium value throughout the USACE process, from initial conceptual planning, project development and design through construction and operation. **As Engineering Divisions lose experienced designers, there is a direct and negative impact on providing quality services and products to internal and external customers.** Senior personnel can be replaced by junior personnel in a numerical sense, but the quality and proficiency of work will not be identical. Engineers with fewer than five years of experience require closer supervision, more training, and more intensive review to ensure that the technical work is well organized and executed and that technical errors and omissions have been detected and corrected. Less experienced engineers take longer to accomplish design than more senior engineers, and this adversely influences the schedule and budget components of product quality. In sum, less experienced engineers cannot independently provide the same degree of technical completeness as senior designers.

Design quality deteriorates when an organization loses design experience, especially at the first level of supervision. This is the current situation in USACE. Two data calls on structural engineering experience in all USACE offices revealed that the average experience of USACE structural engineers decreased by about one year between April 1991 and July 1992. This decrease was due to a combination of factors: transfers to higher graded positions in other

functional offices, other governmental agencies, and private industry; freezes on hiring and high-grades; and uncertainty about the impacts of USACE reorganization. The collective experience of the DQTF indicates that this loss of experience is typical of other Corps engineering disciplines, that the demand for experienced design engineers will not decrease, and that this situation must be a major concern to the USACE senior leadership. It is imperative that we reverse this trend of losing technical expertise.

RECOMMENDATIONS FOR HQUSACE

In the body of the report, the DQTF makes several Engineering Division recommendations that are designed to improve the technical completeness of products as USACE implements PPM. These recommendations, if implemented by all of the USACE functional divisions, will ensure the Corps' ability to maintain its technical competence and will improve the quality of its projects. The DQTF recommends that HQUSACE take the following measures if the Corps is to remain a viable and competitive organization that is capable of responding to the nation's needs.

Recommendation #1 -- Strongly reinforce a commitment to **Project Quality and Functional Product Quality**.

The DQTF recommends that the Chief of Engineers, as the corporate leader of USACE, reinforce his commitment to the quality of projects which is the keystone to providing Corps customers with effective projects and services that meet all of their requirements and expectations. Quality design is the thread that runs through the fabric of all USACE technical products. Emphasizing technical quality should also result in improvements in meeting budgets and schedules because better products cost less when they are done correctly the first time.

Recommendation #2 -- Develop an action plan to attract and retain technical expertise--establish **Dual-Career Tracks**.

The DQTF recommends that USACE continue to pursue, and place a high priority on attracting, developing and retaining technical expertise. Implementation of a dual-career track system for the Engineer and Scientist Career Program (e.g., the Directorate of Human Resources proposal that has been forwarded to OPM) is a key element in achieving product quality. The dual-career track should enable USACE to retain experts in positions where they provide the most value to the organization and enhance the Corps' ability to produce quality projects. This will permit technical experts to advance to higher grades in nonmanagerial or nonsupervisory positions. Technical experts are valuable to USACE for their ability to foresee problems, to recognize viable alternatives, to solve complex technical problems, to advise other technical personnel throughout USACE and the nation, to mentor and develop junior engineers, and to advance USACE state-of-the-art products. The dual-career track will help to retain technical expertise, which will be more critical as USACE moves to one level of technical review. (USACE reorganization into new, more robust technical centers should contribute significantly to enhancing the technical quality of the USACE work force that does planning and engineering.)

Recommendation #3 -- Emphasize **Project Management/Technical Management (PM/TM)** team roles and responsibilities across USACE.

The DQTF recommends that USACE apply Total Army Quality/Total Quality Management (TAQ/TQM) principles to the business processes through the Project Management System. Quality projects result from the performance of quality processes in all functional elements of an organization. **PM emphasis is needed because Engineering Divisions, by themselves, cannot improve all of the processes and systems necessary to produce quality projects for USACE customers.** The interdependencies between functions can best be integrated by a corporate quality management approach that is implemented by the District Engineer. Life-cycle accountability for time, cost, and completeness is essential to ensure that the corporate focus is on the project rather than on the individual functional products.

Recommendation #4 -- Use resources effectively through **Design Partnering**.

The DQTF recommends that USACE encourage and actively support the practice of design partnering. Design partnering is not a brokering concept, it is a way to improve quality by matching unique technical capability with unpredictable workload. This cooperative execution of design work between offices will enhance USACE's ability to deliver timely, affordable, high quality projects to its customers. It capitalizes and preserves the technical expertise of its design work force. Design partnering will work well with the current or reorganized USACE structure.

CONCLUSION

The Corps of Engineers faces a number of challenges:

- Developing and delivering quality projects
- Reducing the cost of doing business
- Maintaining technical competence

USACE is striving for an experienced technical staff that is capable of producing **quality projects** the first time. The Corps wants its customers and partners to equate USACE with **technically-complete** and **cost-effective** solutions to their problems. The Design Quality Task Force believes that the implementation of its recommendations will make USACE the technical organization of choice--the organization that can effectively and efficiently serve the nation now and into the twenty-first century.

USACE: **Excellent Projects on Time** and **within Budget**

CONTENTS

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DQTF Report (29 Jan 93)

I. INTRODUCTION

"**We Believe** we are the best public engineering agency in the world and are determined to make ourselves better to serve our Nation's needs."
(*From the U.S. Army Corps of Engineers (USACE) Vision Statement.*)

1. **PURPOSE.** To make ourselves better, the U.S. Army Corps of Engineers (USACE) Deputy Director of Civil Works commissioned a Design Quality Task Force (DQTF) to identify problems and recommend solutions that will maintain and improve the quality of the Corps' design products. This paper describes and documents the results of the task force efforts.

2. **SCOPE.** This report--

a. Describes the DQTF process.

b. Gives recommendations for maintaining and improving design quality in USACE.

c. Provides detailed annexes as backup material.

3. **BACKGROUND.**

a. At the June 1991 Engineering and Construction Division Chiefs Conference in San Diego, California, Mr. Ray Navidi (Chief, Design Branch, Huntington District) made a presentation that said the **quality** of the Corps' products in the future may be in jeopardy.

> There is concern among the technical staff that the Corps' design products in the future may be of lower quality than they have been to date. . . . Changes within the past few years . . . have had considerable impact on the agency's traditional way of planning, designing and constructing the Civil Works projects. While these changes are aimed for completing projects on time and within budget, design quality, which has been the Corps' hallmark, seems to have been overlooked.[2]

The source of his remarks was an informal survey that he administered to 82 engineers in Engineering Divisions of the USACE district offices (See **Annex A**). This survey and Mr. Navidi's presentation at the Engineering and Construction Division Chiefs Conference were the impetus for the formation of the Design Quality Task Force.

[2] Maintaining Design Quality in the Corps of Engineers, G. Ray Navidi, June 1991.

b. Design quality is the integral thread that is woven from the planning stage where the concepts are developed and baselines are established through the plans and specifications to the actual construction. This integral thread is the most appropriate avenue for examining the potential to make USACE better, and for maintaining and improving the quality of Corps products.

c. The DQTF was established by Mr. Herbert H. Kennon, the Deputy Director of Civil Works, in November 1991. He charged the DQTF to identify specific problems and recommend solutions for maintaining and improving the quality of USACE engineering products.

4. **MEMBERSHIP.** The members of DQTF and its Senior Advisory Group are listed in **Figure 1.** Mr. Ken Akers was selected to chair the DQTF. He assembled a Senior Advisory Group (SAG), chaired by Mr. Art Denys.

SENIOR ADVISORY GROUP (SAG)

Chair, Arthur DENYS, P.E.	Ch, Engr Dir, Southwestern Division
Richard ARMSTRONG, P.E.	Ch, Engr Div, Military Programs Dir, HQUSACE
Paul BARBER, P.E.	Ch, Engr Div, Civil Works Dir, HQUSACE
Hal SMITH, P.E.	Ch, Engr Div, Mobile District

MEMBERS

Chair, Ken AKERS, P.E.	Ch, Engr Dir, South Atlantic Division
Bill AUGUSTINE	Dep Ch, Proj Mgmt Div, Civil Works Dir, HQUSACE
Carl BETTERTON, P.E.	Ch, Engr Div, Galveston District
Bill BRANCH, P.E.	Ch, H & H Br, Portland District
Don DRESSLER, P.E.	Ch, Structures Br, Civil Works Dir, HQUSACE
Ed DAUGHERTY, P.E.	Act Ch, Tech Engr Div, North Pacific Division
Ed EAST, P.E.	Ch, Engr Mgmt Br, Military Programs Dir, HQUSACE
Joe HARTMAN, P.E.	Struct Br, Civil Works Dir, HQUSACE
Doug KAMIEN, P.E.	Ch, Gen Engr Br, Civil Works Dir, HQUSACE
Larry LANG, Ph.D., P.E.	Sr Proj Dir, Engr Strategic Studies Center
Bob LYNCH, P.E.	Ch, Geotech Br, Jacksonville District
Dan MARSALONE, P.E.	Ch, Design Br, New Orleans District
John McPHERSON, P.E.	Dep Ch, Civil Works Engr Dir, HQUSACE
Ed MIDDLETON, Ph.D., P.E.	Ch, Engr Div, Jacksonville District
G. Ray NAVIDI, P.E.	Ch, Design Br, Huntington District
Charles SPITZACK, P.E.	Ch, Design Br, St. Paul District
Ervell STAAB, P.E.	Ch, Arch/Struct Br, Missouri River Division
Jim VANDERSAND, P.E.	Asst Ch, Engr Div, Fort Worth District

Figure 1. COMPOSITION OF DESIGN QUALITY TASK FORCE

5. **GENERAL STUDY METHOD**. The DQTF convened for the first time in Jacksonville, Florida, on 19-20 November 1991 under the direction of Mr. Ken Akers of the South Atlantic Division. At this introductory session, Mr. Akers identified the multipronged approach for accomplishing the DQTF mission. The DQTF defined quality projects and products (paragraph 6), outlined the characteristics of effective Engineering Divisions in USACE (paragraph 7), identified specific tasks, and formed four subgroups.

a. **Subgroup A -- Customer Survey**. A customer survey was chosen to solicit the customer views on Engineering's current quality and to determine how Engineering compares with the concept of effective Engineering Divisions. The survey was limited to internal elements of the Corps. The DQTF acquired the services of the Engineer Strategic Studies Center (ESSC) to help develop and administer the survey, produce results, and assist in interpretation of data.

b. **Subgroup B -- Policies and Procedures**. This group's goal was to identify changes in policies and procedures that will strengthen the relationships between Engineering and its internal and external customers. As the basis for its analysis and recommendations, this group examined district procedures for preparing the various design documents. It initially focused on the Civil Works process. As a means of generating data, it used a workshop of Civil Works and Military Construction Design Branch Chiefs (DBC) to address issues that crossed the subgroups. To assess quality improvement, this group also reviewed existing regulations and manuals.

c. **Subgroup C -- Production Tools**. The goal of this group was to evaluate the effectiveness of the production tools used in management and design and to recommend improvements. A key data-collection mechanism was the DBC workshop. Topics included in this group were design quality goals, management tools, and technical tools such as automation.

d. **Subgroup D -- Work Force**. This group's goal was to evaluate the effectiveness of the Corps' Engineering work force and to improve their involvement in producing quality design products. This group solicited comments from division-level reviewers of products, incorporated data from the DBC workshop, and collected some statistics on personnel turnover.

In addition to working on these formalized assignments, members assisted in analyzing data, making recommendations, and writing portions of the DQTF Report.

6. **DEFINITION OF USACE QUALITY PROJECTS AND PRODUCTS.** The DQTF started with the premise that quality projects are achieved only when there is a mutual agreement between the customer and the provider with respect to that which will be provided. The **project** is the overall, or macro, consideration for USACE. **Products** are components of a project that are produced by the technical functional elements.

a. **Quality Projects**. Quality projects meet all customer-defined expectations and requirements with respect to technical completeness or functionality, budget (cost), and schedule (time). In order for USACE to produce quality projects, it must balance three primary components--**completeness**, **cost**, and **time**. **Figure 2** is a symbol representing the interrelationships of the three primary components of quality projects.

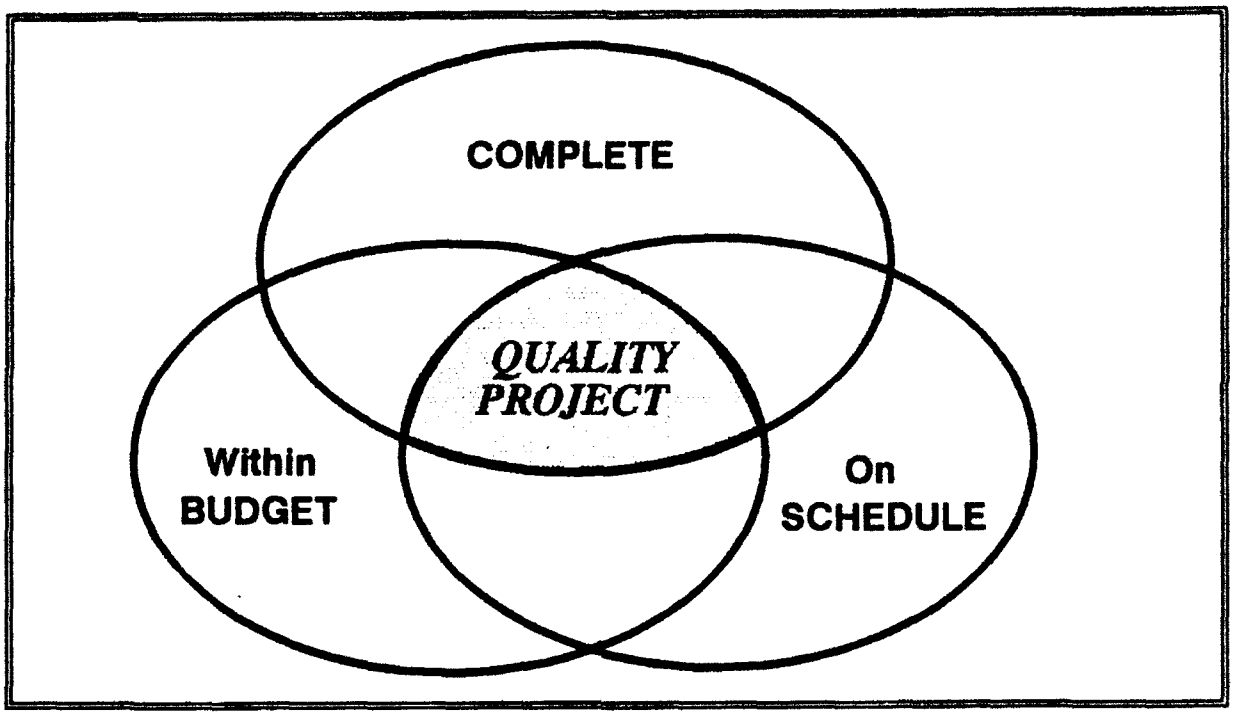

Figure 2. COMPONENTS OF A QUALITY PROJECT

Note that a **quality project** is the area of intersection of the three separate components. If a project is produced on time but costs too much, it is not a quality project. If a project is delivered within budget but is late, it is not a quality project. If a project is on time and within budget but is not technically complete, it is not a quality project. If there is unbalanced emphasis on any of these components, the other components tend to slip.

b. **Quality Products.** Quality products meet all customer-defined expectations and requirements with respect to technical completeness or functionality, budget (cost), and schedule (time) considerations at a micro level. For the individual technical elements of USACE, a **quality product** is the area of intersection of the same three separate components of a project. **Figure 3** shows the components of a quality product. Note that a **quality product** is the area of intersection of the three separate components. If a product is produced on time but costs too much, it is not a quality product. If a product is delivered within budget but is late, it is not a quality product. If a product is on time and within budget but is not technically complete, it is not a quality product. Again, if there is unbalanced emphasis on any of these components, the other components tend to slip.

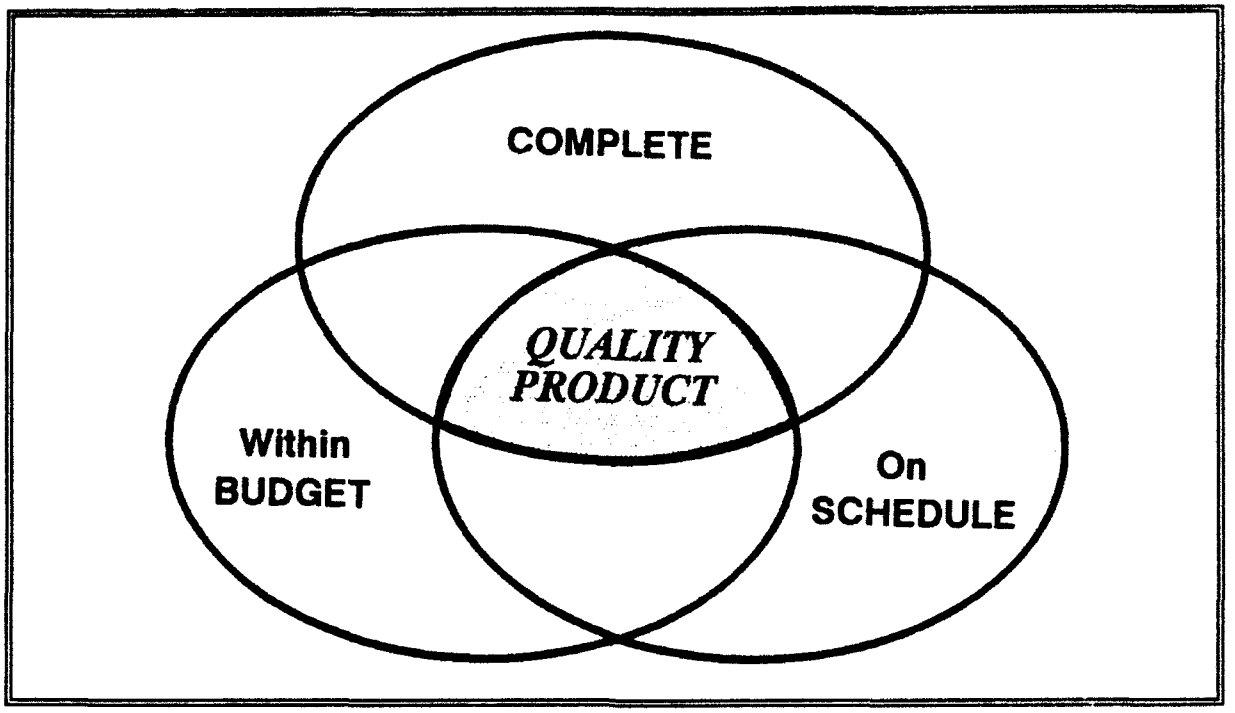

Figure 3. COMPONENTS OF A QUALITY PRODUCT

c. **Figure 4** shows the interrelationships of **Project and Product Quality** in USACE. The corporate focus is on delivering projects to customers. All the individual functional elements (Planning, Engineering, Construction, Operations, Real Estate, Logistics, and Others) must produce quality products that are integrated into the overall **Project**. The functional managers are responsible for the technical quality of functional products. The project manager is responsible for integrating the pieces so that USACE can deliver **quality projects** to its external customers. Working within this framework or context of USACE delivering Quality Projects, the DQTF set out to assess the state of Engineering product quality as seen by its internal customers (Planning, Program/Project Management, Construction, and Operations) and to determine what could be done to improve product quality in the Engineering Divisions of the USACE Districts.

7. **EFFECTIVE ENGINEERING DIVISIONS.** A ***Quality Project*** is the result of Engineering Divisions and all other functional elements working *effectively* as part of an integrated USACE team. The DQTF wanted to develop *effective* Engineering Divisions that are totally integrated with the USACE Project Management System. It began by describing the characteristics of how an *effective* Engineering Division works as part of the integrated USACE team. The DQTF spent considerable time discussing the workings of the Engineering Divisions at the district level and how to make all of them *effective* Engineering Divisions. (The internal customer survey was used to assess the performance of Engineering Divisions and the quality of their products at district level.) What are the characteristics of an *effective* Engineering Division?

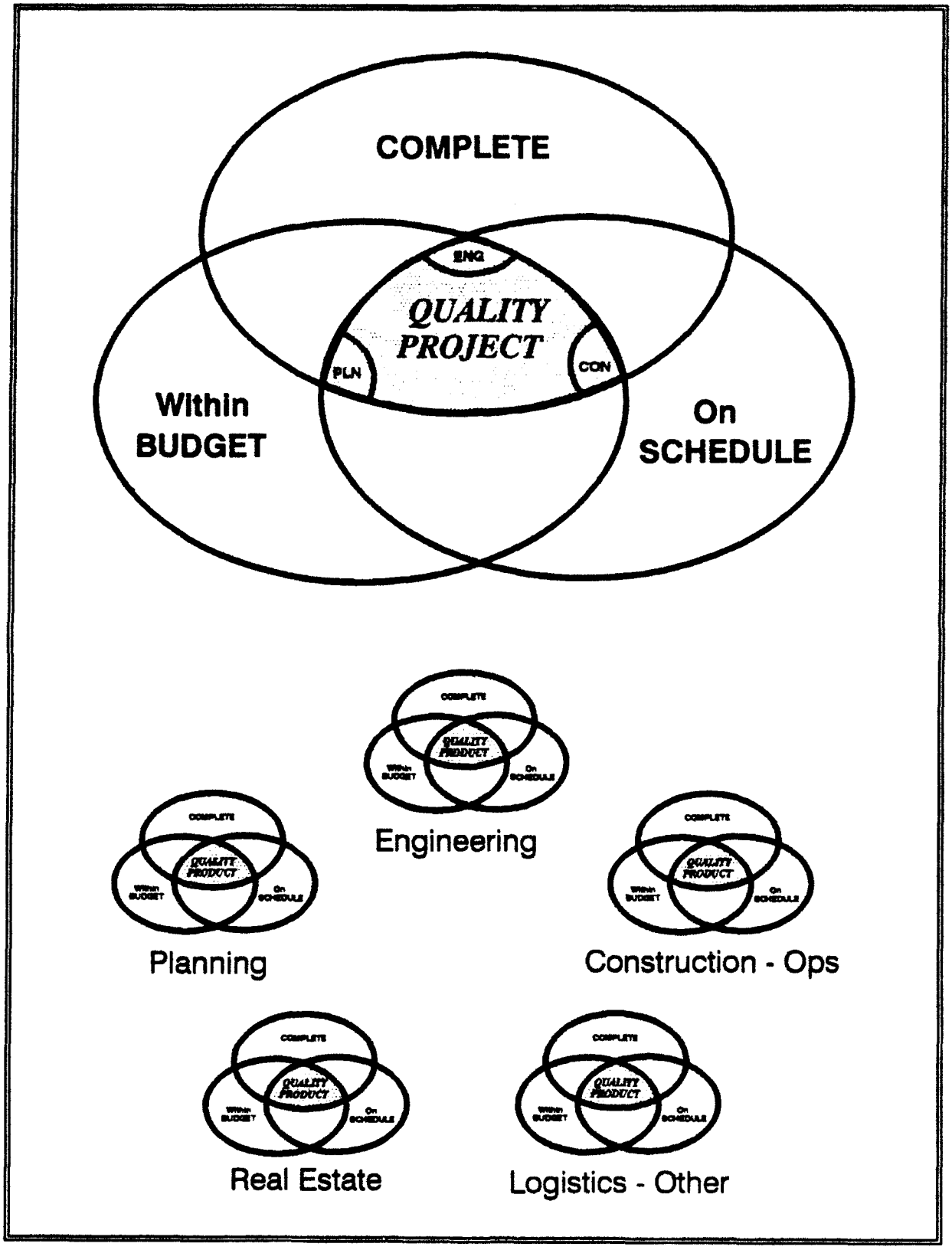

Figure 4. CONCEPT OF PROJECT AND PRODUCT QUALITY IN USACE

a. An *effective* Engineering Division has technically competent people who have a common end focus and who work in an atmosphere that allows them to be successful. It has highly-developed communication channels across, upward, and downward. Development of technical skills is an ongoing activity. Engineers visit project sites prior to and during construction to improve the production of quality designs. An *effective* Engineering Division understands the roles, responsibilities, and perspectives of the other line functions and works with them to consistently produce quality products (i.e., products that are technically complete, on time, and within budget). Because the organization fosters mutual trust and respect, difficulties are addressed straight forwardly in a manner that allows for resolution and leaves intact organizational harmony.

b. An *effective* Engineering Division has earned the confidence of higher authority and is working toward a level of greater internal independence while maintaining accepted lines of communication and reporting. Its work force has the necessary technical and managerial skills. Leadership exists at all levels in the organization. They are team players. They know the mission and work program of the district, and know how the engineering division fits with the whole. Each knows his/her role and what is needed specifically for the whole organization to produce quality products. Each is accountable for his/her contribution. Senior engineers mentor, train, and develop junior engineers. Work force flexibility is enhanced through mastery of contracting with architectural/engineering (A-E) firms and worksharing agreements with other Corps offices and government agencies.

c. An *effective* Engineering Division has a quality management process in place that clearly defines how work is to be accomplished in the Engineering Division. The process is sufficiently flexible to accommodate projects over a broad range of type, size, and complexity. An *effective* Engineering Division also recognizes the importance of independent reviews in assessing product quality, and informs the independent reviewers on salient project features and issues throughout product development. An *effective* Engineering Division has a clearly developed technical management philosophy that is fully integrated into the Project Management System. For each product, it prepares work plans that complement the overall Initial Project Management Plan (IPMP) and Project Management Plan (PMP). Each work plan clearly presents project/product requirements, a schedule with intermediate deliverables of participating functional elements, estimates of engineering and design costs for each functional element, and assumptions under which the plan was formulated. Knowledge of the Engineering Division's total program, both current and future, allows for accurate program planning and management.

d. An *effective* Engineering Division anticipates the need to perform unexpected and unscheduled work, but it is disciplined to not actually perform such work until impacts are discussed at appropriate levels in the organization and an agreement is reached on resources and how to proceed. An *effective* Engineering Division works within defined procedures for progress and quality reviews, work plans revisions, quality control, and criteria management.

e. An *effective* Engineering Division is environmentally sensitive, responds to customer requests, develops customer specific criteria, learns from its mistakes, and seeks continuous improvement in its performance and productivity.

With these thoughts and objectives in mind, the DQTF embarked on the task of assessing the performance of the district Engineering Divisions and making the USACE Engineering Divisions into **effective Engineering Divisions.**

8. **MAJOR MILESTONES.** The formation of the DQTF and the initial meeting in November 1991 were described earlier. Subsequent meetings and major milestones are summarized below in chronological order.

a. The second meeting was held in New Orleans on 8-9 January 1992. At this session, Subgroup A and ESSC described how the quality of Engineering products would be assessed by means of a survey of internal USACE customers (and Engineering Division). The task force agreed to focus at the district level and asked ESSC to develop, finalize, and take care of all administration and initial analysis of the survey data. Subgroups B, C, and D made preliminary reports on their findings.

b. A Design Branch Chief Workshop was held in Dallas-Fort Worth on 21-22 February 1992. At this workshop, the DBC's from 10 Civil and Military districts discussed problems and potential solutions for improving design quality. Portions of tasks in Subgroups B, C, and D were also addressed.

c. The third meeting was held in Jacksonville, Florida, on 15-17 April 1992. The Senior Advisory Group (SAG) attended and provided guidance to the task force. At this session, ESSC briefed the results of the customer survey (and provided everyone with a report containing the survey results). Subgroups B, C, and D gave updated findings on their efforts. Preliminary recommendations and the outline of the final report were developed.

d. The fourth meeting was held in Portland, Oregon, on 17-18 September 1992. At this session the task force reviewed and revised the first draft (white) report. The SAG met and reviewed the second draft (blue) report in Jacksonville, Florida, on 8-9 October 1992. The Subgroup Chairmen met at ESSC on 29-30 October 1992 and revised the draft (buff) report that had incorporated the SAG recommendations. On 12 November 1992, the (green) version of the draft report was express mailed to all the DQTF members for their review and comments prior to preparation of the final report. The SAG met at ESSC on 6 January 1993 to review and approve the DQTF (gold) report. The final report was given to Mr. Herbert H. Kennon on 29 January 1993.

II. CUSTOMER SURVEY AND RESULTS

9. **GENERAL SURVEY APPROACH.** ESSC developed the Engineering Product Quality Survey/Questionnaire in conjunction with Subgroup A and the task force members, and mailed questionnaire packets to all the U.S.-based districts. **Figure 5** shows which districts received the Civil Works Only, or the Civil Works and Military Construction, questionnaire packets.

CIVIL WORKS (CW) ONLY			CW & MILITARY CONSTRUCTION	
Albuquerque	Little Rock	Rock Island	Alaska	New York
Buffalo	Memphis	San Francisco	Baltimore	Norfolk
Charleston	Nashville	St. Louis	Fort Worth	Omaha
Chicago	New England	St. Paul	Honolulu	Sacramento
Detroit	New Orleans	Vicksburg	Kansas City	Savannah
Galveston	Philadelphia	Walla Walla	Los Angeles	Seattle
Huntington	Pittsburgh	Wilmington	Louisville	Tulsa
Jacksonville	Portland		Mobile	

NOTE: CW districts received 40 questionnaires: 8 each for Planning, Construction, PPM, Operations, and Engineering. CW and MC districts received 64 questionnaires: 40 for CW (same as above) and 24 for MC (8 each for PPM, Construction, and Engineering).

Figure 5. DISTRICT SURVEY RECIPIENTS

10. **GAP SURVEY METHOD.** ESSC used a gap survey instrument/questionnaire to measure issues relevant to producing quality products in the Engineering Divisions. The gap survey compares how important respondents feel issues are with their perception of the "Level Today" of the quality of products produced in their Engineering divisions. The difference between the "Importance" score and the "Level Today" score is the "Gap."

a. **Definition of Design Quality.** The respondents were given the following definition of Design Quality on the instruction sheet of the questionnaire:

> A product/design that conforms to the customer/client needs and expectations (i.e., functional and technical requirements, aesthetic features), is consistent with appropriate technical criteria, and meets agreed-upon time and cost estimates. Sample Engineering Division products are: Studies; Analyses; Cost Estimates; Technical Appendices; Design Memoranda; Designs; Plans; Specifications; and Technical Reports.

Note that this definition of Design Quality embraces all three components of a quality product--**Completeness**, **within Budget** (cost), and **on Schedule** (time).

b. The gap survey consisted of one set of 25 issues. Separate questionnaire forms were used for Civil Works and Military Construction (See **Figure 6** for a sample combined questionnaire). District respondents were requested to rate the "Importance" of each issue on a 5-point scale (1 = Low, 5 = High); respondents also rated the "Level Today" that their Engineering Division is performing using the same 5-point scale (1 = Low, 5 = High). In addition, all respondents were asked to identify the three "MOST IMPORTANT Issues TO WORK NOW" to improve product quality in their district for their Engineering Division.

c. ESSC mailed the surveys directly to all the district Engineering Divisions chiefs and asked them to distribute within the district. In addition to their divisions, the Chiefs of Engineering had packets to give to Planning, Construction, PPM, and Operations. The chiefs of the other functional elements were then asked to complete a questionnaire and to distribute the remaining seven questionnaires within their elements to branch chiefs (two), section chiefs (two), and journeymen (three). The individual respondents were asked to complete the questionnaire, seal it in the ESSC-provided envelope, and return the sealed envelope (for confidentiality) to the Chief of the Engineering Division. The Chief of Engineering collected and packaged the sealed responses in an envelope and mailed them to ESSC. Some respondents mailed the surveys directly to ESSC.

11. **SURVEY RESPONSE RATES.** ESSC mailed the 38 questionnaire packets to the districts on 31 January 1992 and requested that the respondents mail their completed survey forms to ESSC two weeks after receiving the questionnaire. The cutoff date for the information presented in this report was 18 April 1992. ESSC used a generic spreadsheet package and processed the data on a microcomputer.

a. ESSC mailed a total of 1880 questionnaires to the districts. All 37 districts and the New England Division responded to the survey by the cutoff date.[3] The number of Overall responses for districts ranged from 14 to 55, with an average of 32 per district. (The number of CW responses ranged from 7 to 36, with an average of 26 per district. The number of MC responses ranged from 2 to 22, with an average of 15 per district.) The overall response rate of 65.5 percent was distributed as follows: 65.7 percent for the Civil Works districts and 64.4 percent for the Military Construction districts.

b. **Figure 7** shows the distribution of responses by PROGRAM (Civil Works, Military Construction, and Overall), by FUNCTION (Engineering, Construction, PPM, Planning, and Operations), and by POSITION (Division Chief, Branch/Section Chief, and Journeyman).

[3] Although the New England Division (NED) is an operating division, ESSC considered their responses to reflect the operating level of engineering. Thus, the 35 responses from NED were treated as district responses.

How **IMPORTANT** are these issues **FOR DESIGN QUALITY** in USACE?
What **LEVEL TODAY** is Engineering on these issues?

ISSUES (CW & MC)	IMPORTANCE LOW HIGH	LEVEL TODAY LOW HIGH
Engineering --		
1. is responsive to your requests for products/services.	1 2 3 4 5	1 2 3 4 5
2. discusses with you the scope and requirements prior to initiating work.	1 2 3 4 5	1 2 3 4 5
3. maintains open communications.	1 2 3 4 5	1 2 3 4 5
4. visits the project site to clarify requirements prior to initiating work.	1 2 3 4 5	1 2 3 4 5
5. produces cost effective products.	1 2 3 4 5	1 2 3 4 5
6. visits the project site during design.	1 2 3 4 5	1 2 3 4 5
7. products are commensurate with the scope, complexity, and schedule of the project.	1 2 3 4 5	1 2 3 4 5
8. products are cost effective for **small projects** (Planning or CA < $5M; Construction < $2M; Operations < $1M. For MC, Small Projects < $1M).	1 2 3 4 5	1 2 3 4 5
9. products meet your requirements.	1 2 3 4 5	1 2 3 4 5
10. delivers products on schedule.	1 2 3 4 5	1 2 3 4 5
11. products meet the requirements of the **local sponsor/Instl.**	1 2 3 4 5	1 2 3 4 5
12. effectively incorporates environmental considerations.	1 2 3 4 5	1 2 3 4 5
13. has technically competent people.	1 2 3 4 5	1 2 3 4 5
14. has the correct number of people to do its mission.	1 2 3 4 5	1 2 3 4 5
15. delivers technically adequate products.	1 2 3 4 5	1 2 3 4 5
16. delivers products within budget.	1 2 3 4 5	1 2 3 4 5
17. has an adequate review process for its products.	1 2 3 4 5	1 2 3 4 5
18. plans and specs are complete for construction contracts.	1 2 3 4 5	1 2 3 4 5
19. provides timely products for changes to contracts.	1 2 3 4 5	1 2 3 4 5
20. has a complete understanding of requirements prior to initiating work.	1 2 3 4 5	1 2 3 4 5
21. seeks feedback on the quality of its products.	1 2 3 4 5	1 2 3 4 5
22. has an effective "lessons learned" system.	1 2 3 4 5	1 2 3 4 5
23. provides "state of the art" products.	1 2 3 4 5	1 2 3 4 5
24. policies and criteria are flexible.	1 2 3 4 5	1 2 3 4 5
25. effectively coordinates its work in the Engineering Division.	1 2 3 4 5	1 2 3 4 5

* **Please circle 3 issues above that are the most important to work on now.** *

Figure 6. QUESTIONNAIRE

CATEGORIES	CIVIL WORKS # RESPONSES	MILITARY CONSTRUCTION # RESPONSES	TOTAL # RESPONSES
OVERALL			
Engineering	261	92	353
Construction	193	91	284
PPM	153	49	202
Planning	226	-.-	226
Operations	166	-.-	166
TOTAL	**999**	**232**	**1,231**
POSITIONS			
Division Chief	84	22	106
Branch/Section Chief	478	117	595
Journeyman	430	92	522
TOTAL*	**992**	**231**	**1,223**
***NOTE: Totals do not agree because some respondents did not indicate position.**			

Figure 7. NUMBER OF RESPONSES

12. **RESULTS.** The symbols shown below are used to assist in data presentation throughout this report:

the average or mean "**IMPORTANCE,**"

the average or mean "**LEVEL TODAY,**"

the average or mean "**GAP,**" and,

the number (and percentage) of votes for the "**MOST IMPORTANT**" Issues for Engineering Divisions "**TO WORK NOW**" to improve quality.

Figure 8 is a summary of the Overall (CW + MC) **customer responses** from the survey. [4] Responses for Engineering are not included in this report unless noted.

[4] ESSC has rounded to one decimal place for all survey results.

CUSTOMER AVERAGES [878 Responses] (Const, Plan, PPM, and Ops Data) CW AND MC ISSUES Engineering -- --	(a) IMPORTANCE	(b) LEVEL TODAY	(a - b) GAP	MOST IMPORTANT TO WORK *NOW* # Responses (%)
1. is responsive to your requests for products/services.	4.5	3.3	1.2	100 (4.6)
2. discusses scope & rqmts before starting work.	4.2	3.2	1.0	47 (2.2)
3. maintains open communications.	4.5	3.4	1.1	99 (4.6)
4. visits project site before starting work.	4.2	3.3	0.9	39 (1.8)
5. produces cost effective products.	4.5	2.9	1.6	164 (7.6)
6. visits the project site during design.	4.3	3.2	1.1	69 (3.2)
7. products are commensurate with scope, complexity, and schedule of the project.	4.4	3.2	1.2	92 (4.2)
8. products are cost effective for small projects.	4.3	2.7	1.6	135 (6.2)
9. products meet your requirements.	4.4	3.4	1.0	40 (1.8)
10. delivers products on schedule.	4.5	2.9	1.6	251 (11.6)
11. products meet requirements of local sponsor or installation.	4.5	3.5	1.0	71 (3.3)
12. effectively incorporates environmental considerations.	4.3	3.6	0.7	45 (2.1)
13. has technically competent people.	4.6	3.9	0.7	59 (2.7)
14. has correct number of people to do its mission.	4.1	3.2	0.9	57 (2.6)
15. delivers technically adequate products.	4.5	3.7	0.8	63 (2.9)
16. delivers products within budget.	4.5	2.9	1.6	208 (9.6)
17. has an adequate review process for its products.	4.2	3.2	1.0	70 (3.2)
18. plans and specs are complete for const. contracts.	4.5	3.4	1.1	134 (6.2)
19. provides timely products for changes to contracts.	4.3	3.3	1.0	81 (3.7)
20. has complete understanding of rqmts before starting.	4.4	3.3	1.1	33 (1.5)
21. seeks feedback on the quality of its products.	4.0	2.7	1.3	52 (2.4)
22. has an effective "lessons learned" program.	4.1	2.5	1.6	107 (4.9)
23. provides "state of the art" products.	3.9	3.1	0.8	28 (1.3)
24. policies and criteria are flexible.	4.0	2.7	1.3	65 (3.0)
25. effectively coordinates its work in Engr Div.	4.2	3.2	1.0	58 (2.7)

Figure 8. SUMMARY RESULTS -- OVERALL (CW + MC DATA)

a. **Graphic Display of Responses.** **Figures 9** through **12** below show in graphic form the pattern of customer responses to the survey questions. The dotted bars represent the number of responses (from Construction, Operations, Planning, and PPM) for "Importance" of the issue. The crisscrossed bars represent the responses for the "Level of Performance Today" for the Engineering Divisions in the USACE districts. The *Average Importance*, *Average Level Today*, and *GAP* statistics are shown in a box under the issue title in each chart. Because the survey results do not have a wide range (i.e., all numbers are between 1 and 5), these charts clearly show that there is indeed a difference between scores of 4.6 and 3.9. The "Gap" of 0.7 in Figure 9 represents the narrowest or smallest "Gap" across the 25 issues in the survey. Similarly, the "Gaps" of 1.6 shown in Figures 10 through 12 represent some of the widest or largest in the survey. In Figure 9, note that 590 customers rated the "Importance" of *Engineering Has Technically Competent People* as high (5), while only 210 customers rated the "Level of Performance Today" as equally high.

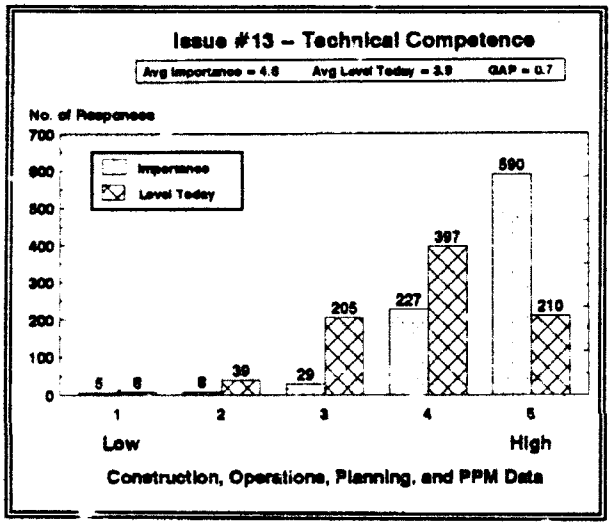

Figure 9. TECHNICAL COMPETENCE RESULTS

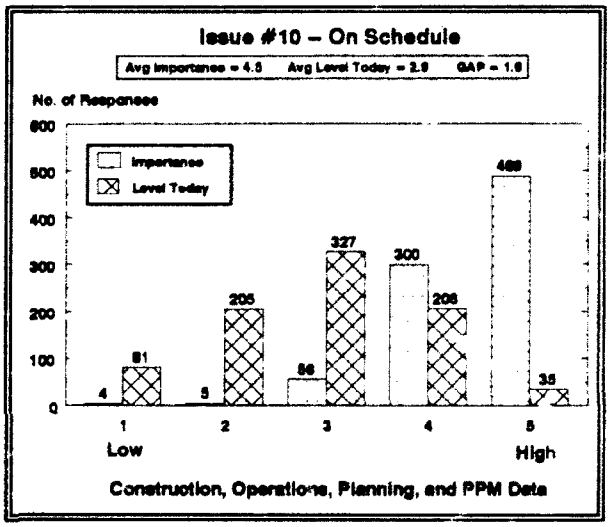

Figure 10. ON SCHEDULE RESULTS

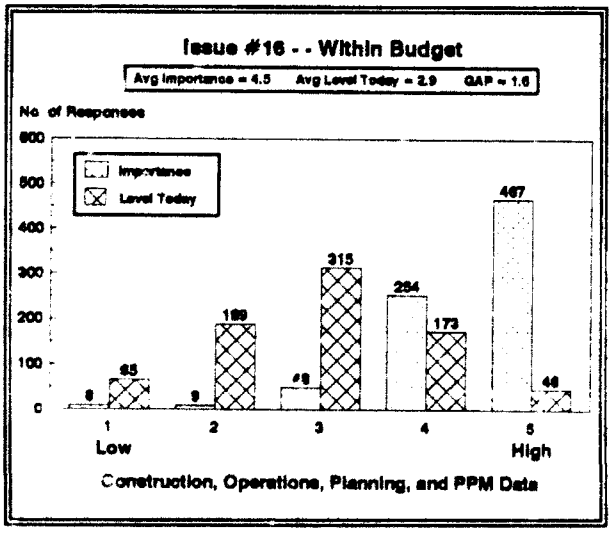

Figure 11. WITHIN BUDGET RESULTS

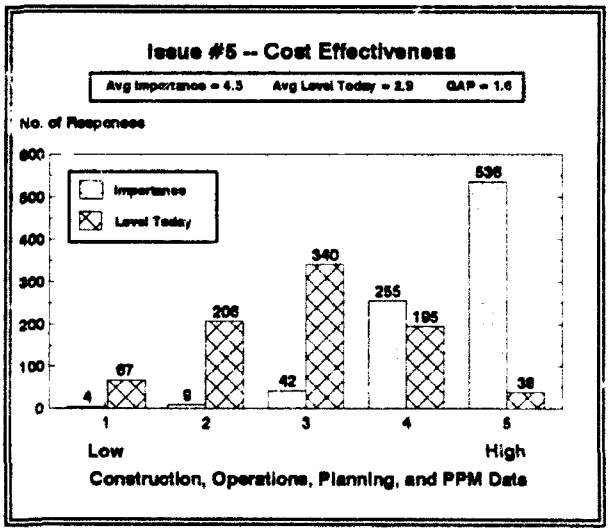

Figure 12. COST EFFECTIVENESS RESULTS

b. **Importance**. The ***Importance*** column of Figure 8 presents the mean score for the "Importance" of each issue with respect to design quality. The respondents could choose from 1 (Low Importance) through 5 (High Importance) for each issue on the questionnaire. In general, they rated most issues at the high end of the scale. The "Importance" scores for the 25 issues ranged from a low of 3.9 to a high of 4.6. As an example, Issue #1--*Engineering Is Responsive to Your Requests for Products/Services*--had a mean score of 4.5 for "Importance." Nine issues received the two highest scores in "Importance"--*Technical Competence* was highest with a score of 4.6. Eight issues tied for second highest with a score of 4.5. The lowest scoring item on "Importance" was Issue #23--*State-of-the-Art Products*.

OVERALL -- IMPORTANCE Issues
Top & Bottom Mean Scores
(Const, Plan, PPM, and Ops Data)

Issue		Mean Score
#13	Technical Competence	4.6
#1, #3, #5, #10, #11, #15, #16 & #18		4.5
#22	"State of the Art" Products	3.9

c. **Level Today**. The ***Level Today*** column of Figure 8 shows the mean score for the perceived level of performance by the Engineering Divisions on each issue. As with "Importance," the respondents could choose from 1 (Low Performance) to 5 (High Performance). The "Level Today" scores for the 25 issues ranged from a low of 2.5 to a high of 3.9. As an example, for Issue #1--*Engineering Is Responsive to Your Requests for Products/Services*--the mean score for "Level Today" was 3.3. The highest score on "Level Today" was 3.9 for Issue #13--*Technical Competence*. The next highest scores were 3.7 for Issue #15--*Technically Adequate Products*--and 3.6 for Issue #12--*Environmental Considerations*. The lowest score was 2.5 for Issue #22--*Effective "Lessons Learned" Program*.

OVERALL -- LEVEL TODAY Issues
Top & Bottom Mean Scores
(Const, Plan, PPM, and Ops Data)

Issue		Mean Score
#13	Technical Competence	3.9
#15	Technical Adequacy	3.7
#12	Environmental Considerations	3.6
#22	Effective Lesso..; Learned	2.5

d. **Gap.** The column *Gap* contains the numeric difference between the mean scores for the "Importance" of the issue and the perceived "Level Today" of the USACE Engineering Divisions in the districts. Again, using Issue #1 and data from Figure 8, the "Gap" between the "Importance" of being *Responsive to Your Requests for Products/Services* and the "Level Today" of Engineering is 1.2 -- this is a large difference. Note that "Gaps" can be either positive or negative. In this survey, over 99 percent of all "Gaps" were positive (i.e., the "Level Today" score (performance) is less than "Importance" score for the issue). The smallest "Gaps" were Issue #12--*Environment* (0.7), and Issue #13--*Technical Competence* (0.7). This is where the Engineering Divisions are doing **BEST** across all the issues in aggregate terms. There may be differences between Function, Program, or Position based on more refined looks at the survey data.

OVERALL -- GAPS
Widest & Narrowest
(Const, Plan, PPM, and Ops Data)

Issue		Gap
#5	Cost Effective Products	1.6
#8	Small Projects	1.6
#10	On Schedule	1.6
#16	Within Budget	1.6
#22	Effective "Lessons Learned"	1.6
#12	Environmental Considerations	0.7
#13	Technical Competence	0.7

e. **Most Important Issues to Work NOW.** ESSC also requested each respondent to identify the three most important issues its Engineering Division should work on NOW to improve design quality. The ***Most Important to Work NOW*** column in Figure 8 shows the number of times (and percent) the issue was identified in the survey. Many respondents failed to identify the three "Most Important to Work NOW" issues, and some selected only one or two issues. The total number of customer items selected was 2,167. See the table below for the top vote getters. For example, Issue #10 received 251 votes or 11.6 percent.

OVERALL -- ISSUES TO WORK NOW
Five Most Important
(Const, Plan, PPM, and Ops Data)

Issue		Votes	Percentage
#10	On Schedule	251	11.6%
#16	Within Budget	208	9.6%
#5	Cost Effective Products	164	7.6%
#8	Cost Effective Small Projects	135	6.2%
#18	Complete Plans & Specifications	134	6.2%

13. **RESULTS BY FUNCTION.** Survey results for each function are shown in separate figures as indicated below:

- **Figure 13** -- **CONSTRUCTION** Function (CW + MC Data)
- **Figure 14** -- **PPM** Function (CW + MC Data)
- **Figure 15** -- **PLANNING** Function (CW Data)
- **Figure 16** -- **OPERATIONS** Function (CW Data)

a. As an additional source of information, the DQTF collected data from Engineering Division personnel using the same Gap Survey instrument. **Figure 17** shows the results of the Engineering responses for the combined Civil Works and Military Construction (Overall) Programs. As mentioned earlier, these Engineering results were not included with the customer data write-up in the previous sections.

b. In general, the Engineering Division's score on "Level Today" performance is higher than any other function. This factor translates into a lower "Gap" score on almost every issue for the Engineering Division when its results are compared with any other functional element. This is not an unexpected result.

c. *Engineer Pamphlet 1110-1-12, Gap Survey Method for Assessing Design Quality in USACE District-Level Engineering Organizations*, contains the data results for all issues on the ESSC design quality survey.

CONSTRUCTION Data (284 Respondents) CW AND MC ISSUES Engineering --	(a) IMPORTANCE	(b) LEVEL TODAY	(a - b) GAP	MOST IMPORTANT TO WORK *NOW* # Responses (%)
1. is responsive to your requests for products/services.	4.5	3.4	1.1	27 (3.9)
2. discusses scope & rqmts before starting work.	3.9	2.7	1.2	12 (1.7)
3. maintains open communications.	4.5	3.6	0.9	22 (3.2)
4. visits project site before starting work.	4.3	2.8	1.5	26 (3.7)
5. produces cost effective products.	4.4	3.1	1.3	30 (4.3)
6. visits the project site during design.	4.5	2.7	1.8	55 (7.9)
7. products are commensurate with scope, complexity, and schedule of the project.	4.3	3.4	0.9	14 (2.0)
8. products are cost effective for small projects.	4.1	3.0	1.1	21 (3.0)
9. products meet your requirements.	4.4	3.4	1.0	3 (0.4)
10. delivers products on schedule.	4.3	3.0	1.3	39 (5.6)
11. products meet requirements of local sponsor or installation.	4.6	3.6	1.0	23 (3.3)
12. effectively incorporates environmental considerations.	4.3	3.7	0.6	6 (0.9)
13. has technically competent people.	4.6	3.8	0.8	25 (3.6)
14. has correct number of people to do its mission.	4.1	3.4	0.7	8 (1.1)
15. delivers technically adequate products.	4.5	3.6	0.9	19 (2.7)
16. delivers products within budget.	4.2	3.2	1.0	20 (2.9)
17. has an adequate review process for its products.	4.5	3.1	1.4	41 (5.9)
18. plans and specs are complete for const. contracts.	4.7	3.1	1.6	119 (17.1)
19. provides timely products for changes to contracts.	4.6	3.0	1.6	66 (9.5)
20. has complete understanding of rqmts before starting.	4.4	3.3	1.1	9 (1.3)
21. seeks feedback on the quality of its products.	4.1	2.7	1.4	23 (3.3)
22. has an effective "lessons learned" program.	4.3	2.5	1.8	55 (7.9)
23. provides "state of the art" products.	3.8	3.0	0.8	11 (1.6)
24. policies and criteria are flexible.	3.9	2.9	1.0	12 (1.7)
25. effectively coordinates its work in Engr Div.	4.2	3.3	0.9	10 (1.4)

Figure 13. CONSTRUCTION RESULTS SUMMARY -- OVERALL (CW + MC Data)

PPM Data (202 Respondents) CW AND MC ISSUES Engineering -- --	(a) IMPORTANCE	(b) LEVEL TODAY	(a - b) GAP	MOST IMPORTANT TO WORK *NOW* # Responses (%)
1. is responsive to your requests for products/services.	4.6	3.4	1.2	16 (3.1)
2. discusses scope & rqmts before starting work.	4.4	3.5	0.9	7 (1.4)
3. maintains open communications.	4.6	3.2	1.4	29 (5.6)
4. visits project site before starting work.	4.2	3.7	0.5	0 (0.0)
5. produces cost effective products.	4.6	2.9	1.7	42 (8.1)
6. visits the project site during design.	4.2	3.6	0.6	2 (0.4)
7. products are commensurate with scope, complexity, and schedule of the project.	4.5	3.2	1.3	24 (4.6)
8. products are cost effective for small projects.	4.2	2.5	1.7	25 (4.8)
9. products meet your requirements.	4.4	3.6	0.8	7 (1.4)
10. delivers products on schedule.	4.7	2.9	1.8	87 (16.8)
11. products meet requirements of the local sponsor or installation.	4.6	3.6	1.0	16 (3.1)
12. effectively incorporates environmental considerations.	4.4	3.8	0.6	4 (0.8)
13. has technically competent people.	4.6	4.0	0.6	11 (2.1)
14. has correct number of people to do its mission.	4.2	3.1	1.1	23 (4.4)
15. delivers technically adequate products.	4.6	3.8	0.8	19 (3.7)
16. delivers products within budget.	4.7	2.7	2.0	93 (18.0)
17. has an adequate review process for its products.	4.2	3.4	0.8	14 (2.7)
18. plans and specs are complete for const. contracts.	4.4	3.6	0.8	6 (1.2)
19. provides timely products for changes to contracts.	4.3	3.4	0.9	6 (1.2)
20. has complete understanding of rqmts before starting.	4.3	3.4	0.9	6 (1.2)
21. seeks feedback on the quality of its products.	3.8	2.8	1.0	6 (1.2)
22. has an effective "lessons learned" program.	3.9	2.5	1.4	21 (4.1)
23. provides "state of the art" products.	3.9	3.1	0.8	6 (1.2)
24. policies and criteria are flexible.	4.1	2.7	1.4	21 (4.1)
25. effectively coordinates its work in Engr Div.	4.4	3.1	1.3	27 (5.2)

Figure 14. PPM RESULTS SUMMARY -- OVERALL (CW + MC Data)

PLANNING Data (226 Respondents) CW ISSUES Engineering – –	(a) IMPORTANCE	(b) LEVEL TODAY	(a - b) GAP	MOST IMPORTANT TO WORK *NOW* # Responses (%)
1. is responsive to your requests for products/services.	4.5	3.3	1.2	30 (5.4)
2. discusses scope & rqmts before starting work.	4.4	3.4	1.0	15 (2.7)
3. maintains open communications.	4.4	3.2	1.2	31 (5.5)
4. visits project site before starting work.	4.1	3.6	0.5	4 (0.7)
5. produces cost effective products.	4.6	2.9	1.7	51 (9.1)
6. visits the project site during design.	4.2	3.7	0.5	5 (0.9)
7. products are commensurate with scope, complexity, and schedule of the project.	4.5	3.0	1.5	44 (7.9)
8. products are cost effective for small projects.	4.5	2.7	1.8	55 (9.8)
9. products meet your requirements.	4.4	3.4	1.0	14 (2.5)
10. delivers products on schedule.	4.5	2.8	1.7	68 (12.2)
11. products meet requirements of the local sponsor or installation.	4.6	3.4	1.2	25 (4.5)
12. effectively incorporates environmental considerations.	4.3	3.3	1.0	28 (5.0)
13. has technically competent people.	4.6	3.9	0.7	14 (2.5)
14. has correct number of people to do its mission.	4.1	3.2	0.9	17 (3.0)
15. delivers technically adequate products.	4.5	3.7	0.8	18 (3.2)
16. delivers products within budget.	4.5	2.9	1.6	58 (10.4)
17. has an adequate review process for its products.	4.0	3.3	0.7	6 (1.1)
18. plans and specs are complete for const. contracts.	4.3	3.8	0.5	4 (0.7)
19. provides timely products for changes to contracts.	4.0	3.5	0.5	1 (0.2)
20. has complete understanding of rqmts before starting.	4.4	3.3	1.1	11 (2.0)
21. seeks feedback on the quality of its products.	3.9	2.6	1.3	8 (1.4)
22. has an effective "lessons learned" program.	3.9	2.6	1.3	11 (2.0)
23. provides "state of the art" products.	3.9	3.1	0.8	4 (0.7)
24. policies and criteria are flexible.	4.2	2.6	1.6	22 (3.9)
25. effectively coordinates its work in Engr Div.	4.2	3.2	1.0	15 (2.7)

Figure 15. PLANNING RESULTS -- (CW Data)

OPERATIONS Data (166 Respondents) CW ISSUES Engineering – –	(a) IMPORTANCE	(b) LEVEL TODAY	(a - b) GAP	MOST IMPORTANT TO WORK *NOW* # Responses (%)
1. is responsive to your requests for products/services.	4.5	3.2	1.3	27 (6.9)
2. discusses scope & rqmts before starting work.	4.5	3.5	1.0	13 (3.3)
3. maintains open communications.	4.5	3.5	1.0	16 (4.1)
4. visits project site before starting work.	4.2	3.4	0.8	9 (2.3)
5. produces cost effective products.	4.5	2.7	1.8	40 (10.2)
6. visits the project site during design.	4.1	3.1	1.0	7 (1.8)
7. products are commensurate with scope, complexity, and schedule of the project.	4.3	3.3	1.0	10 (2.6)
8. products are cost effective for small projects.	4.5	2.7	1.8	34 (8.7)
9. products meet your requirements.	4.5	3.5	1.0	16 (4.1)
10. delivers products on schedule.	4.4	2.8	1.6	56 (14.3)
11. products meet requirements of the local sponsor or installation.	4.1	3.3	0.8	7 (1.8)
12. effectively incorporates environmental considerations.	4.3	3.8	0.5	7 (1.8)
13. has technically competent people.	4.6	3.9	0.7	9 (2.3)
14. has correct number of people to do its mission.	4.0	3.2	0.8	9 (2.3)
15. delivers technically adequate products.	4.5	3.7	0.8	7 (1.8)
16. delivers products within budget.	4.5	2.9	1.6	37 (9.5)
17. has an adequate review process for its products.	4.1	3.3	0.8	9 (2.3)
18. plans and specs are complete for const. contracts.	4.5	3.6	0.9	5 (1.3)
19. provides timely products for changes to contracts.	4.2	3.4	0.8	8 (2.0)
20. has complete understanding of rqmts before starting.	4.4	3.3	1.1	7 (1.8)
21. seeks feedback on the quality of its products.	4.1	2.6	1.5	15 (3.8)
22. has an effective "lessons learned" program.	4.2	2.5	1.7	20 (5.1)
23. provides "state of the art" products.	4.1	3.3	0.8	7 (1.8)
24. policies and criteria are flexible.	4.0	2.7	1.3	10 (2.6)
25. effectively coordinates its work in Engr Div.	4.0	3.2	0.8	6 (1.5)

Figure 16. OPERATIONS RESULTS -- (CW Data)

ENGINEERING Data (353 Respondents) CW AND MC ISSUES Engineering – –	(a) IMPORTANCE	(b) LEVEL TODAY	(a - b) GAP	MOST IMPORTANT TO WORK *NOW* # Responses (%)
1. is responsive to your requests for products/services.	4.5	3.7	0.8	17 (2.0)
2. discusses scope & rqmts before starting work.	4.4	3.7	0.7	11 (1.3)
3. maintains open communications.	4.6	3.8	0.8	40 (4.6)
4. visits project site before starting work.	4.3	3.5	0.8	8 (0.9)
5. produces cost effective products.	4.5	3.4	1.1	50 (5.8)
6. visits the project site during design.	4.3	3.4	0.9	19 (2.2)
7. products are commensurate with scope, complexity, and schedule of the project.	4.4	3.6	0.8	26 (3.0)
8. products are cost effective for small projects.	4.1	3.0	1.1	38 (4.4)
9. products meet your requirements.	4.5	3.9	0.6	12 (1.4)
10. delivers products on schedule.	4.4	3.4	1.0	72 (8.3)
11. products meet requirements of the local sponsor or installation.	4.6	4.0	0.6	30 (3.5)
12. effectively incorporates environmental considerations.	4.4	4.0	0.4	9 (1.0)
13. has technically competent people.	4.7	4.0	0.7	78 (9.0)
14. has correct number of people to do its mission.	4.3	3.0	1.3	78 (9.0)
15. delivers technically adequate products.	4.7	4.1	0.6	47 (5.4)
16. delivers products within budget.	4.4	3.3	1.1	70 (8.1)
17. has an adequate review process for its products.	4.3	3.5	0.8	37 (4.3)
18. plans and specs are complete for const. contracts.	4.6	4.0	0.6	25 (2.9)
19. provides timely products for changes to contracts.	4.4	3.9	0.5	5 (0.6)
20. has complete understanding of rqmts before starting.	4.4	3.4	1.0	45 (5.2)
21. seeks feedback on the quality of its products.	4.1	3.0	1.1	27 (3.1)
22. has an effective "lessons learned" program.	4.1	2.7	1.4	43 (5.0)
23. provides "state of the art" products.	4.0	3.3	0.7	9 (1.0)
24. policies and criteria are flexible.	4.0	3.0	1.0	47 (5.4)
25. effectively coordinates its work in Engr Div.	4.5	3.6	0.9	25 (2.9)

Figure 17. ENGINEEPING RESULTS SUMMARY -- OVERALL (CW + MC Data)

14. **ADDITIONAL SURVEY DATA.** As mentioned earlier, *Engineer Pamphlet 1110-1-12* contains the data results for all issues on the ESSC design quality survey. **Figure 18** is a sample page from the ESSC Design Quality Survey Report for Issue #10--*Engineering Division Delivers Projects On Schedule*. This figure shows the wealth of information that is available for each issue on the questionnaire. It enables Engineering chiefs to share the results with the other division chiefs in their organizations. Figure 18 contains the data for the issue that was voted "Most Important to Work NOW" to improve quality.

a. The "Gap" data have some characteristics that are particularly noteworthy. To cite a specific example, refer to the data in the table below for Issue #10--*On Schedule*. Please note that Engineering has a significantly lower "Gap" than any other function. The Engineering Division views its performance at a much higher level on this issue than all other elements. The largest difference on this item is with the PPM element because of both "Importance" of the issue (Engineering = 4.4 vs PPM = 4.7) and the perceived "Level Today" performance (Engineering = 3.4 vs PPM = 2.9). The resulting "Gap" difference is dramatic (Engineering = 1.0 vs PPM = 1.8).

FUNCTIONAL COMPARISON OF "GAPS" FOR ISSUE #10 (ON SCHEDULE) -- OVERALL DATA

FUNCTION	IMPORTANCE	LEVEL TODAY	GAP	COMMENT
Avg w/o Engr	**4.5**	**2.9**	**1.6**	Customer Data Average
Construction	4.3	3.0	1.3	--
PPM	4.7	2.9	1.8	Highest Imp, Largest Gap
Planning	4.5	2.8	1.7	Lowest Level, Very Large Gap
Operations	4.4	2.8	1.6	Lowest Level, Very Large Gap
Engineering	4.4	3.4	1.0	Highest Level, Smallest Gap
AVG w/Engr	4.4	3.1	1.3	Survey Data Average w/Engr

b. Similar comparisons of the "Gap" data for Issue #10 (see Figure 18, Overall data) can be made by Position or Program. For example, the Division Chief "Gap" for the Average without Engineering (Avg w/o Engr) data equalled 1.8, the Branch/Section Chief "Gap" equalled 1.5, and the Journeyman "Gap" equalled 1.6. If the survey data by Position are viewed using the Average with Engineering (AVG w/Engr) results, the corresponding information is the Division Chief "Gap" equalled 1.5, the Branch/Section Chief "Gap" equalled 1.4, and the Journeyman "Gap" equalled 1.4.

FUNCTION	CIVIL WORKS			MILITARY CONSTRUCTION			OVERALL		
	IMPORTANCE	LEVEL	GAP	IMPORTANCE	LEVEL	GAP	IMPORTANCE	LEVEL	GAP
OVERALL									
Avg w/o Engr	4.5	2.9	1.6	4.5	2.9	1.6	4.5	2.9	1.6
Construction	4.3	3.0	1.3	4.4	2.9	1.5	4.3	3.0	1.3
PPM	4.7	2.9	1.8	4.7	3.0	1.7	4.7	2.9	1.8
Planning	4.5	2.8	1.7	-.-	-.-	-.-	4.5	2.8	1.7
Operations	4.4	2.8	1.6	-.-	-.-	-.-	4.4	2.8	1.6
Engineering	4.4	3.5	0.9	4.4	3.3	1.1	4.4	3.4	1.0
AVG w/Engr	4.5	3.0	1.5	4.4	3.1	1.3	4.4	3.1	1.3
DIVISION CHIEF									
Avg w/o Engr	4.7	2.9	1.8	4.8	3.0	1.8	4.7	2.9	1.8
Construction	4.6	2.8	1.8	4.8	3.3	1.5	4.7	2.9	1.8
PPM	4.9	2.9	2.0	4.8	2.5	2.3	4.9	2.9	2.0
Planning	4.6	3.1	1.5	-.-	-.-	-.-	4.6	3.1	1.5
Operations	4.8	2.9	1.9	-.-	-.-	-.-	4.8	2.9	1.9
Engineering	4.5	3.7	0.8	4.5	3.6	0.9	4.5	3.7	0.8
AVG w/Engr	4.7	3.1	1.6	4.6	3.3	1.3	4.7	3.2	1.5
BRANCH/SECTION CHIEF									
Avg w/o Engr	4.5	2.9	1.6	4.4	2.9	1.5	4.4	2.9	1.5
Construction	4.3	3.0	1.3	4.3	2.8	1.5	4.3	3.0	1.3
PPM	4.8	2.7	2.1	4.8	3.2	1.6	4.8	2.9	1.9
Planning	4.5	2.7	1.8	-.-	-.-	-.-	4.5	2.7	1.8
Operations	4.4	2.8	1.6	-.-	-.-	-.-	4.4	2.8	1.6
Engineering	4.4	3.5	0.9	4.3	3.3	1.0	4.4	3.4	1.0
AVG w/Engr	4.5	3.0	1.5	4.4	3.1	1.3	4.4	3.0	1.4
JOURNEYMAN									
Avg w/o Engr	4.5	2.9	1.6	4.5	3.0	1.5	4.5	2.9	1.6
Construction	4.3	3.1	1.2	4.3	3.0	1.3	4.3	3.1	1.2
PPM	4.7	2.9	1.8	4.6	3.0	1.6	4.7	2.9	1.8
Planning	4.4	2.9	1.5	-.-	-.-	-.-	4.4	2.9	1.5
Operations	4.4	2.8	1.6	-.-	-.-	-.-	4.4	2.8	1.6
Engineering	4.2	3.4	0.8	4.4	3.3	1.1	4.3	3.4	0.9
AVG w/Engr	4.4	3.0	1.4	4.5	3.1	1.4	4.4	3.0	1.4

Figure 18. ISSUE 10 -- ENGINEERING DELIVERS PRODUCTS ON SCHEDULE

15. **SUMMARY OBSERVATIONS.** The customer survey results contain some important insights for Engineering Divisions.

a. The combined total results of the survey showed that *Technical Competence, Meeting External Requirements, Producing Technically Adequate Products, Open Communications, Responsive to Requests, Cost Effective Products, Within Budget, On Schedule,* and *Producing Complete Plans and Specifications* received the highest scores on "Importance" when averaged across all functional elements in the USACE districts. **Figure 19** is a comparison of the top scores from the survey.

ISSUE	IMPORTANCE	LEVEL TODAY	GAP	WORK *NOW*
#13 Technical Competence	4.6 [1]	3.9 [1]	0.7	59
#15 Technical Adequacy	4.5 [2]	3.7 [2]	0.8	63
#11 Meet External Requirements	4.5 [2]	3.5 [4]	1.0	71
# 3 Open Communications	4.5 [2]	3.4	1.1	99
#18 Complete Plans & Specs	4.5 [2]	3.4	1.1	134
# 1 Responsive to Requests	4.5 [2]	3.3	1.2	100
# 5 Cost Effective Products	4.5 [2]	2.9	1.6 [1]	164 [3]
#16 Within Budget	4.5 [2]	2.9	1.6 [1]	208 [2]
#10 On Schedule	4.5 [2]	2.9	1.6 [1]	251 [1]

"Importance" scores range from 1 (Low) - 5 (High).
"Level Today" scores range from 1 (Low) - 5 (High).
"Gap" = "Importance" - "Level Today."
"Work on NOW" values are *Number of Responses.*
Numbers in [ ] are *Ranks.*

NOTE: All Data from **Figure 8.** (Const, Plan, PPM, and Ops)

Figure 19. TOP RANKED ISSUES BY IMPORTANCE, LEVEL TODAY, GAP, AND WORK NOW -- OVERALL (CW + MC Data)

b. The information shown in brackets in Figure 19 represents the rank of that particular item based on the Overall survey data results (See Figure 8). Thus, *Technical Competence* received the highest score in "Importance" and also the highest score in "Level Today." *Producing Cost Effective Products, Producing Products on Schedule, and Producing Products Within Budget* had the WIDEST "Gaps" and were the three items with the greatest number of selections for "Most Important for Engineering Division to Work NOW" to improve quality. Three of the highest "Importance" items also received the highest scores on the "Level Today" performance. However, there must be a cautionary note to those findings. The "Gap"

scores for Issues #13, #15, and #11, while among the lowest in the survey, show that there is considerable room for improvement by Engineering Divisions across the Corps in the eyes of the survey respondents. Note also that several of the highest scoring "Importance" items (#5, #16, and #10) had the WIDEST "Gaps" in the survey.

c. Survey respondents had an opportunity to make comments about design quality on the survey form. Over 400 people responded. The essence of their comments follows:

(1) *Engineering Division's Personnel Capability/Responsiveness.* A large majority of the respondents agreed that, for the most part, Engineering has dedicated and hard-working personnel. The problems seem to stem from their lack of field training, use of ineffective processes in the Engineering Division, and timeliness of responses to requests from the user(s).

(2) *Quality Versus Schedule.* Several comments specifically express concern about the growing trend of meeting deadlines without regard to the quality of the product. This often results in plans and specifications being incomplete or insufficiently reviewed.

(3) *Retainability and Recruitment of Personnel.* Because of the grade structure in Engineering, personnel often transfer to Project Management or seek jobs in private industry. The consensus is that the Corps is not actively seeking young engineers. This will result in a lack of continuity and a fully developed skill base within the future Corps.

d. The task force focused its attention on the items with the largest "Gaps" and the highest "Work on NOW" scores. These are the areas where there is the greatest perceived discrepancy in the performance of the Engineering Divisions and, hence, the areas for greatest payoff.

e. The remaining sections of this task force report present an analysis of the customer survey data, the findings from the other subgroups, and the overall conclusions and recommendations.

III. ANALYSIS OF CUSTOMER SURVEY RESULTS

16. **INTRODUCTION.** In the ESSC customer survey each respondent was asked to identify the three most important issues which Engineering Division should work on now to improve the quality of its products. The top five issues which received the highest scores were selected for further analysis by the task force. **Figure 20** shows the issues from the questionnaire and the top five ranks for each USACE functional element. The ranking is based on the number of people who marked that issue as one of the three that Engineering Divisions should concentrate efforts NOW to improve product quality (i.e., the top rank goes to Issue No. 10--*Delivers Products on Schedule*). Issue #10 was identified by the largest number (251) of respondents. Note that Planning and Operations had this as the highest rank. PPM ranked it second, and Construction ranked it fifth. The following paragraphs describe the methodology used to address these issues.

(1) Issues are considered individually in accordance with their ranking. Overall ranking is used when issues are considered to be equally important across functional areas. Ranking by individual functional areas is used in cases where issues are considered to be important to only one functional area. For example, Issue No. 18--*Completeness of Plans and Specs*--is particularly important to the Construction Division; therefore, the ranking given by the Construction Division is used as a basis for addressing this issue.

(2) A discussion is presented for each issue based on the findings of DQTF and some recommended solutions are provided. Sources used for this analysis are the 1991 Designer Survey (which was the primary basis for the formation of the DQTF), discussions from the Design Branch Chiefs (DBC's) Workshop that was held in conjunction with the DQTF, meetings of the DQTF, comments contained on the ESSC Customer Survey questionnaire forms, and informal discussions with members of the Corps' Engineering community.

17. **MOST IMPORTANT ISSUE -- Engineering Delivers Products on Schedule.** This issue was ranked **first** Overall by the internal customers, as well as **first** by Planning and Operations. PPM ranked this issue **second.** The fact that everyone feels Engineering needs to do better in meeting schedules is not surprising since delivery of Engineering products impacts a number of organizations. The question before us is what causes this to be so and what can Engineering do about this shortcoming?

a. **Findings.** The DQTF believes that the following factors contribute to this problem.

(1) ***Unscheduled Work.*** Some of the Design Branch Chiefs (from DBC's Workshop) estimated that as much as 30 to 50 percent of their work is unknown. This is a significant organizational problem which is acknowledged by Engineering management but not usually known by other district elements.

RANKING OF THE TOP FIVE MOST IMPORTANT ISSUES TO WORK ON NOW Engineering -- --	CONST RANK	PPM RANK	PLAN RANK	OPNS RANK	OVERALL RANK
1. is responsive to your requests for products/services.				5	
2. discusses scope & rqmts before starting work.					
3. maintains open communications.		4			
4. visits project site before starting work.					
5. produces cost effective products.		3	4	2	3
6. visits the project site during design.	3				
7. products are commensurate with scope, complexity, and schedule of the project.			5		
8. products are cost effective for small projects.			3	4	4
9. products meet your requirements.					
10. delivers products on schedule.	5	2	1	1	1
11. products meet requirements of the local sponsor or installation.					
12. effectively incorporates environmental considerations.					
13. has technically competent people.					
14. has correct number of people to do its mission.					
15. delivers technically adequate products.					
16. delivers products within budget.		1	2	3	2
17. has an adequate review process for its products.	4				
18. plans and specs are complete for const. contracts.	1				5
19. provides timely products for changes to contracts.	2				
20. has complete understanding of rqmts before starting.					
21. seeks feedback on the quality of its products.					
22. has an effective "lessons learned" program.	3				
23. provides "state of the art" products.					
24. policies and criteria are flexible.					
25. effectively coordinates its work in Engr. Div.		5			

Figure 20. MOST IMPORTANT ISSUES -- COMPARISON OF RANKS BY FUNCTION

(2) ***Gradual Loss of Experienced Designers***. Engineering Division efficiency is directly proportional to the level of experience of the design staff. The task force believes that loss of technical talent, whether measured by number or by experience level of the Engineering Division work force, is highly correlated with Engineering Division's current inability to perform up to the expectations of its various internal customers. Lack of talent and experience will result in a given task taking longer, costing more, and being subjected to more errors and omissions. An imbalance between workload and work force, in the context of intense budget/schedule pressure, will result in subtle but systematically degrading quality. This decline in quality is due to inadequate time for training interns, insufficient staff to do coordination and review, no time to seek feedback, crisis management, and other short-term, budget/schedule driven actions. As the senior designers leave for higher grade positions outside the USACE Engineering Divisions, the situation will become worse. Inexperienced or junior designers cannot accomplish the job as efficiently as the more experienced engineers. This factor has a significant impact on all components of quality design.

(3) ***Lack of A Clear Scope (of Project) Up Front***. Project schedules are developed without a clear understanding of what exactly has to be done. In the course of project development, scopes change as project requirements become known; however, schedules usually remain the same. A quote from a PPM respondent of the ESSC survey illustrates this point. Quality design begins with a well defined scope and an appropriate period for preparation of design documents. Both are extremely rare. Crisis management is today's norm."

(4) ***Schedules Established by Others***. In some districts, schedules are set by others outside the Engineering Division, with little or no input from Engineering. Sources: comments contained in the Design Survey (**Annex A**) and the DBC Workshop.

(5) ***Lack of A Management System for A Multiproject Environment***. There is no meaningful management system that provides a view of the organization's total workload and manpower usage. This was a major concern of the DBC's in their workshop. "We are computer slaves inputting data for reports; and have a lack of reliable data from onboard systems (financial systems and networks)."

b. **Recommendations**. The DQTF believes the following recommendations will help to attain better adherence to schedules.

(1) The districts' Engineering management must acknowledge that project schedules cannot be developed in a vacuum without considering the overall district workload, including factors for unanticipated work. Engineering Division Chiefs must explain this to district management. They must also convey the same to their people and insist on realistic schedules which can be adhered to--barring extreme emergencies. Design partnering is an effective means of easing peak workloads and unanticipated work. When appropriate, Indefinite Delivery Contracts (IDC's) should be utilized to eliminate the impact of unforeseen work--recognizing that because of administrative requirements, IDC's cannot be as readily available as sister districts.

(2) Dual-career tracking is needed to retain experienced engineers in the ranks of designers. This is one of the most important factors in Engineering's ability to improve its responsiveness to meeting schedules.

(3) Senior engineers must be encouraged and trained to mentor and develop younger engineers.

(4) Engineering management must ensure that their staff members have a thorough understanding of the project scope before schedules are developed. They must insist that sufficient time is available and devoted to the preparation of project schedules. In cases where a complete scope is not available, Engineering must clearly state its understanding of the scope and the assumptions upon which the schedule is based.

(5) Wholehearted support of team management is necessary to continue improving the PPM system. As a member of the district team, the Engineering Division is responsible for timely delivery of its products to meet the district's overall commitments. Engineering Divisions are responsible for scheduling Engineering activities to accomplish their missions. Once a project schedule is established and the required work force has been assigned to the project, Engineering management must assure that the team members are TOTALLY devoted to the project and that NOTHING will interfere with the progress of that project--including unforeseen work. When working on long-term projects, this will require particularly strict discipline on the part of management--the tendency is to pull resources away to take care of small but immediate jobs, thinking that "we can make up the time later."

(6) Engineering needs a usable multiproject scheduling tool with accurate budget/cost information. This especially applies to the DBC's and other supervisors who have to integrate several project commitments. There are several commercially-available management/scheduling software packages that are user-friendly and can be integrated with USACE's systems. More technical training in scheduling is needed for Engineering Division personnel.

18. **2D ISSUE -- Engineering Delivers Products Within Budget**. Across the board, there is agreement among customers on the significance of completing Engineering's portion of work within budget. Engineering is aware of this shortcoming, and there are a number of things it can do to improve the situation. However, there are also some factors outside Engineering's control that tend to compromise the budget issue.

a. **Findings.** The DQTF believes that the following factors contribute to this problem.

(1) ***Lack of Early Involvement in Defining the Scope of the Project.*** Some Engineering Divisions do not get involved at early stages of projects, and those that do, do not put enough time, effort, and senior/experienced engineers into it. As a result, they later discover that the earlier estimates of engineering and design efforts were seriously underfunded.

(2) ***Lack of A Clear Scope (of Project) Up Front.*** Engineering and design budgets for projects are prepared without a complete understanding of what exactly has to be done. In the course of project development, the scope changes as project requirements become known, requiring additional engineering and design efforts that result in costs exceeding the original estimates.

(3) ***Insufficient Number of Experienced Designers.*** Budgets are prepared assuming that experienced designers are "on board" to do the work. Most often this is not realistic because some Corps districts have been losing their senior designers to higher paying jobs. Inexperienced engineers are not as efficient or effective as senior engineers. ESSC survey comments from a PPM function chief illustrate this point: "In my view, any shortcomings are the result of too much work versus the resources (manpower) available--in most cases."

(4) *Stop-and-Go*. This happens often in both Military and Civil Works projects. The results are loss of efficiency, wasted effort, and unavailability of the same designers when the project is restarted.

(5) ***Business-As-Usual Mindset of Some Engineering Divisions***. Budgets are prepared hastily without giving full consideration to the scope of work--when one is available. Frequently, changes to the scope of work occur, but they are not documented to account for the additional amount of Engineering effort required. The explanation by many managers in Engineering is: "it takes too much time and resources (neither of which we have enough) to monitor and track all the changes."

b. **Recommendations**. The DQTF believes the following recommendations will help to attain lower costs and achieve a better adherence to budget.

(1) Senior engineers should be involved in the early stages of the project. Defining the scope of work for a project must be treated as a "project" in itself. Engineering management must devote appropriate resources to this task to assure all project requirements are clearly defined and budgeted.

(2) In cases where a clear scope of work is not available, Engineering must prepare a partial budget based on the information available at the time. The circumstances under which this budget is prepared must be documented and presented to the appropriate functional element (customer) and district management.

(3) USACE needs a usable multiproject scheduling tool with accurate budget/cost information; this is especially true for the DBC's and other supervisors who have to interface several projects. Several user-friendly management/scheduling software packages are commercially available for integrating with USACE's systems.

(4) USACE needs to develop incentives to keep senior designers in technical disciplines.

(5) USACE must apply the principles of TAQ/TQM to improve all activities within Engineering and where Engineering interfaces with other elements.

(6) Engineering must devote the necessary resources to documenting the impact of various factors affecting the budget. It must account for lost efforts due to scope changes, stop-and-go, or unanticipated engineering problems, to name a few, which have considerable impact on budgets as well as on the schedules.

19. **3D ISSUE -- Engineering Produces Cost Effective Products**. This issue was ranked 3d Overall, 2d by Operations, and 4th by Planning. In the eyes of the internal customers, Engineering must become more cost effective.

a. **Findings.** ***Cost Effectiveness Is Tied to the Corps' Criteria (Issue No. 24) Which, According to Engineering, Needs to Be More Flexible.*** This is something entirely within the Engineering Division's control and should be addressed by HQ. Currently, there is an initiative by CECW-ED to investigate ways to cut the cost of navigation projects. Part of this effort is aimed at relaxing the existing policies and criteria that govern the design of navigation projects. This relaxation can result in more economical construction. Similar efforts should be initiated for all types of projects. The ongoing Civil Works Update Program (underway since 1989) will have a major positive impact on the cost effectiveness of USACE's products.

b. **Recommendations.** The DQTF believes the following recommendations will help to achieve more cost-effective products.

(1) Experienced designers must mentor and develop the junior engineers assigned to projects. This will result in more efficient design processes and design products.

(2) USACE should study existing criteria and revise, where appropriate, to allow for innovations which will reduce cost.

(3) USACE should evaluate criteria based on the value-added concept.

(4) Engineering should use proven, current standard designs where applicable. There should be more interchange of designs between districts.

(5) USACE should streamline and simplify the review process.

(6) USACE should better utilize the CADD system.

(7) User/sponsor and designers should "buy in" early on scope and budget.

20. **4TH ISSUE -- Products Are Cost Effective for Small Projects.** This was 4th most important Overall, 3d most important issue for Planning, and 4th most important for Operations. Engineering concurs that significant improvement is needed in this area. We can and must do a much better job on small projects.

a. **Findings.** The DQTF believes that the following factors contribute to this problem.

(1) ***Shortage of Experienced Designers.*** Due to a shortage of senior engineers, experienced designers are unable to work on small projects.

(2) ***Same Criteria for Large and Small Projects.*** The Engineering Division and the Corps use the same criteria for designing both large and small projects.

(3) ***Same Process for Large and Small Projects.*** We use the same subsurface investigations, hydraulics and structural considerations, reporting requirements, etc. for small projects as we do for larger, more complex projects. This is an issue that can be addressed and solved by the Engineering Divisions if they concentrate efforts on the small projects process.

b. **Recommendations**. The DQTF believes the following efforts will make small projects more cost effective.

(1) Engineering should use senior engineers to do the entire job without routing it through all technical elements.

(2) Engineering should study existing criteria and revise where appropriate.

(3) The Military Program initiative--Simplified Design Method--should be expanded and used in Civil Works.

(4) USACE should streamline the design and review process, and should perform risk analysis.

(5) USACE should reward performance on the small projects and should have a Small Project of the Year Award.

(6) USACE should review the small projects process and simplify as much as possible, including more delegation (i.e., division to district and within district).

(7) Engineering should establish a multidisciplinary team or section for designing small projects.

21. **5TH ISSUE -- Plans and Specifications Are Complete for Construction Contracts**. A Construction Division Chief commented: "There is too much concern nowadays with meeting schedules--we turn out too many products that are 80-90% complete. We pay for it with construction mods and claims." This issue was ranked 5th Overall, but the Construction Division, who is the main customer of this product, rated it 1st. This is a prime example of the need for balancing the three components of the quality product and the tradeoffs which USACE and Engineering must balance in its program. Plans and specifications are the last lines of defense for ensuring the quality of USACE's products. In addition to keeping the customer/user satisfied, we, as federal employees, are obligated and have a duty to protect the **interest of taxpayers**. Incomplete plans and specifications invariably result in costly modifications and claims. It is, therefore, incumbent upon us to concentrate on this issue NOW.

a. **Findings**. There are a number of factors which cause this deficiency and most of them can be corrected by Engineering management.

(1) ***Lack of Genuine Commitment***. Comments contained in the 1991 Design Survey (**Annex A**) highlighted a feeling that Engineering Division management is not genuinely committed to the production of quality products. As one of the respondents remarked: "Management philosophy is: Quality products, on time and within budget; what it really means: give them what they want when they want it, but don't spend too much money doing it."

(2) ***Changing Priorities and Stop-and-Go Effort***. Priorities change in the course of preparing the plans which cause the designers to be pulled away from the job. This results in production inefficiency.

(3) ***Insufficient Number of Experienced Designers to Work on Plans and Specifications***.

(4) ***Unrealistic Scheduling of Plans and Specifications***. In some Engineering Divisions, management commits to schedules knowing that they are impossible to keep. Also, some Engineering Division input indicates that the schedules for completion of plans and specifications are set by other elements.

b. **Recommendations**.

(1) Engineering must better plan the jobs, must put the required resources on each job, and must resist the temptation to pull people off those jobs to put out small fires. This takes **discipline**, and requires experienced people and an effective planning and scheduling tool. There are a number of available commercial software packages that can be easily integrated with USACE's systems. Of course, it does take considerable **resources** to maintain such a system, and Engineering management must allocate the required staffing.

(2) Engineering managers must be honest with themselves, their people, and their superiors about their commitment to quality.

(3) Experienced designers must be assigned to the preparation of plans and specifications, and must devote some time to training the junior engineers in producing complete plans and specifications.

(4) "Production of quality design products" must be included as a **critical job element** in the performance standards of all personnel involved in design. This will provide a balance for all three components of quality products because "adherence to budget and schedule" is already in the performance standards of almost all Engineering management personnel.

(5) Engineering personnel must make more site visits to see first hand the impacts of their designs in the construction and operations stages of projects.

(6) Engineering **is responsible** for the preparation of all designs including the scheduling of activities. These schedules, however, must be sensitive to the overall district constraints and commitments. It is obvious that Engineering Divisions do not have unlimited capabilities and can handle only a finite amount of work in a given time period. Also, some projects cannot be put on hold to suit Engineering's internal priorities. When a district has peak workloads, design partnering can be used, to the extent possible, to correct this deficiency.

22. **2D CONSTRUCTION ISSUE -- Provides Timely Products for Changes to Contracts.** This issue was ranked 2d by Construction Divisions. In Overall ranking, it was near the bottom because no other element is directly involved with it. The fact that Construction feels this is the second most important issue that Engineering needs to work on NOW suggests that quality is a problem. Construction's top issue--*Complete Plans and Specifications*--along with this issue, gives a clear message: Incomplete plans and specifications require changes during construction, and Engineering is not being responsive in providing timely changes. Of course, if Engineering were to do a better job in preparing complete sets of plans and specifications, this issue probably would not be a concern.

a. **Findings**. Many of the Construction comments in the ESSC survey revealed frustration concerning Engineering's responsiveness. Discussions with Engineering people provided some insight as to the reason for this problem.

(1) ***Unavailability of Original Designers***. The designers who worked on the project (now under construction) are now working on another project. **And**, changes on a construction contract usually require the attention of the original designer who cannot be made available without impacting another project.

(2) ***Unavailability of Key Designers***. The nature of construction changes almost always requires the involvement of key designers who are in such demand that no float is built into their schedules.

(3) ***No Prioritization***. The problem faced by many first-line supervisors in Engineering is that their superiors expect them to handle these short-term assignments without impacting other projects. This stems from the inability or unwillingness of some managers to establish priorities for their people--"multiple No. 1 priorities" was cited by many in Engineering.

b. **Recommendations.**

(1) Allowances should be made in full-time equivalent (FTE) requests and allocations for engineering support during construction.

(2) Realistic schedules, which allow for interruptions, should be established.

(3) Priorities should be established. Even under the most ideal conditions, bottlenecks or unexpected problems occur. A priority system that is sanctioned by top management will help determine which project must be given preferential treatment to meet the district's commitment.

(4) Visit the construction site, if necessary, to ensure that the proposed engineering solution will solve the customer's problem.

23. **3D CONSTRUCTION ISSUE -- Effective "Lessons Learned" Program and Visits the Project Site During Construction.** It may not be surprising that there is a tie for these two issues since there is a connection between visiting the construction site and learning from past mistakes. Engineering agrees that it needs to establish, or improve implementation of, an effective "lessons learned" program. The question then is why isn't Engineering doing something about it.

a. **Findings**. The answer may be found in the customer survey comments and in Engineering's responses to the issues. Although this is entirely within the Engineering Division's purview, it does take ***resources*** to maintain an effective program. When resources are scarce, many managers opt to cut out activities that do not result in "tangible" products.

b. **Recommendations**. Both of these issues directly affect the quality of Corps products in the eyes of the customer. Engineering must take immediate steps to start implementing or improving these programs. The most effective "lesson learned" is communication within districts. After a district learns a lesson, it should communicate the "lesson learned" to districts having similar projects. Divisions and HQ can ensure that this is being done.

24. **4TH CONSTRUCTION ISSUE -- Has an Adequate Review Process for Its Products.** In the past, a set of plans and specifications sent out of Engineering for review was 100 percent complete. Essentially, the review set meant "we have done our best, see if you can find things that we may have overlooked."

a. **Findings.** The customer is telling Engineering that its ***products are no longer "the best it could have done."*** This is very disturbing testimony about the quality of Engineering's products and something that demands immediate attention.

b. **Recommendations.** Adequate time for internal review of plans and specifications must be included in the schedules. Engineering Division Chiefs must ensure that their products are submitted for review only after the Design Branch Chiefs have certified that the products are complete.

25. **4TH PPM ISSUE -- Maintains Open Communications.** This concern may be part of the "growing pain" that is experienced by the organization as it continues to improve the project management system.

a. **Findings.** One of the findings to come out of the Design Branch Chiefs' Workshop was that ***Engineering is genuinely working toward improving the system and there is total commitment to the corporate philosophy of PPM.***

b. **Recommendations.** Encourage and reward open lines of communication within the engineering division, and expand working relationships to the other functional elements of the district. The Corps is producing products for external customers and partners. With a cooperative team attitude, let's help USACE satisfy its external customers.

26. **5TH PPM ISSUE -- Effectively Coordinates Its Work in Engineering Division.** This problem is partially due to the early confusion concerning roles and responsibilities between PPM and Engineering.

a. **Findings.** The new Project Management regulation--***ER 5-7-1(FR)--will help delineate the roles and responsibilities***, including the coordination of engineering work.

b. **Recommendations.** The Engineering Division is responsible for coordinating engineering activities within its division. Engineering Division Chiefs must allocate necessary resources to ensure effective internal coordination.

27. **5TH PLANNING ISSUE -- Products Are Commensurate with Scope, Complexity, and Schedule of Projects.** Judging by some of the comments contained in the customer survey, the Planning Division is genuinely troubled by this issue.

a. **Findings.** A few of these Planning comments follow:

• *"Engineering Division is expected to provide increasing level of detail to respond to ASA/HQ micromanagement; and yet decreased funds availability (and schedule flexibility) are in conflict.* ASA/HQ want more stuff done at earlier phases to justify whether to go to next phase, and yet adequate funds are not available because of budget limits."

• *"We try to produce a cost effective product, however, reviewer always asks for more data.* Policies and procedures need to be more flexible (reviewers don't understand new and innovative approaches to a problem)."

b. **Recommendations.** USACE should issue Corps-wide guidance on the level of detail and information required for various documents. The guidance should focus on the reviewers as well as on the designers so that both will have the same interpretation of the intent of the policies and criteria.

28. **5TH OPERATIONS ISSUE -- Is Responsive to Your Requests for Products/Services.** Operations Division personnel feel that the Engineering Division is not being responsive to their needs in a timely manner.

a. **Findings.** A number of factors contribute to this shortcoming. A few examples are *the lack of a priority system, the lack of an effective scheduling system, and the inability of Engineering management to establish priorities.* When different programs compete for the same resources and without a unified corporate position on the goals and objectives, Engineering middle managers tend to put the plans and specifications first and do other jobs as they can.

b. **Recommendations.** Coordinating with district management, Engineering Division Chiefs must establish priorities and set goals for their people. This is crucial to an Engineering Division's ability to give its many customers the timely, quality service that they demand. This is not an easy job, as one of the customers commented: "Since Engineering is so large and provides so many services, it is difficult to answer these broad based questions." However, with good leadership and a corporate approach to solving these problems, it is achievable.

29. **ENGINEERING DIVISION RESPONSES.** The ESSC survey also collected data from the Engineering Divisions. Figure 17 (page 22) shows Engineering Division responses to the questionnaire. Engineering Division personnel were responding to the same issues as the internal customers, but were in a sense asked to rate themselves on the factors deemed to be important for producing quality design products in USACE. In general, the Engineering Division rated its own performance higher than the other survey respondents rated its performance. However, it is interesting to note that within Engineering, engineering's performance was rated higher by Chiefs/Supervisors than by Journeymen engineers. This demonstrates the concern among designers that was surfaced in the Navidi survey (**Annex A**). Journeymen engineers want to produce quality products but sometimes feel constrained by the established process and system; they may be more open than their supervisors.

30. **CONCLUSIONS.** Data gathered by the task force from the ESSC customer survey and other sources provide very useful information that is invaluable to USACE leadership in their attempt to maintain the tradition of the Corps--to be: ". . . the best public engineering agency in the world . . . determined to make ourselves better to serve our Nation's needs."

a. The issues raised here are a corporate concern, because the Corps team cannot be "better" unless every member is better. Engineering products are a common thread in almost everything the Corps does, and, as such, they have a significant impact on the image of USACE in the eyes of the customers. The issues highlighted here are not only Engineering problems, but are ones that easily apply to all district elements supporting the project. The majority of these problems are within the purview of district management and can be corrected by a corporate approach through the application of a genuine TQM process.

b. USACE must learn from the philosophy of today's giant corporations and borrow their "back to basics" business principles, which essentially come down to the reason for the company's existence--to produce a product and to make a profit. The private sector has learned that "customer satisfaction" is the key to their continued existence. USACE is not here for profit, but it is here for a much more significant reason: **to serve the nation**. USACE also must be clear about its purpose. The Corps' purpose in its vision document provides the answer. "Our purpose is 'to provide quality, responsive engineering service to the Nation in peace and war.'" USACE senior leadership must focus and build on that simple principle of satisfying appropriately-scoped customer requirements and must concentrate on producing quality projects.

IV. PROCEDURAL IMPROVEMENTS

31. **INTRODUCTION.** This section summarizes the findings of Subgroup B (Policies and Procedures) and Subgroup C (Production Tools). The task force focused on how USACE does business in the Engineering Divisions and how it can improve the processes. DQTF had the mission of identifying policies and procedures changes that will strengthen the relationships between Engineering and its partners and customers. The task force concluded that an overall push for Total Army Quality/Total Quality Management (TAQ/TQM) was the single most important mechanism that could be applied universally. Our recommendations are presented by major project phases.

a. TAQ/TQM procedures should be used throughout the planning, design, and construction process from project inception to completion. Various design disciplines (Civil, Structural, Mechanical, Electrical, Hydraulics, Geotech), planners, project managers, and customers need to closely coordinate work and work as a team. This takes people who are willing to communicate on a one-to-one basis--across organizational boundaries--to solve their respective problems.

b. At district level, the Corps of Engineers is organized into functions with divisions, branches, and sections. This type of organizational structure can provide good training for young engineers and assurance of technical adequacy by engineers within the function if sufficient workload exists. However, this structured organization sometimes creates barriers between divisions, branches, and sections, thereby impeding quick and efficient work. We believe this structured organization will work effectively if division chiefs and branch chiefs allow their designers, planners, etc. to use their own judgment and make decisions, to include free and open discussions during the course of the design. This synergistic approach to the final planning document or design is consistent with the "power-down" principle of TQM. Changing to a TAQ/TQM corporate philosophy will have a significant impact on improving the design process.

c. The *Water Resources Development Act of 1986* placed additional demands on Corps engineers and planners to work smarter and cut design costs, particularly in the reconnaissance and feasibility stages of design--simply because the local sponsor must share in the costs of these designs. Experienced, innovative, and competent engineers should be utilized early on in the planning stage because many decisions are based on professional judgment without a great deal of data. Because of the salary structure, it is difficult to retain experienced engineers in technical specialties, and as a consequence, there are not enough experienced engineers to do all things. Many districts, therefore, find it necessary to use junior engineers in the early planning stages--using the experienced engineers to do the hard designs, feature design memoranda, and the plans and specifications. The establishment of a dual-career track system will increase career options by providing for a career progression in the technical specialties. This action should improve work force morale and should increase individual and corporate technical capability. Our committee believes that highly motivated and experienced technical engineers will ultimately save their increase in salary costs more than tenfold in reduced overall design and construction costs of projects.

d. During a review of the policies and procedures, the committee identified several areas that could be improved by application of TAQ/TQM. The remainder of this section has paragraphs that contain conclusions and recommendations by the phase of Civil Works process.

32. **RECONNAISSANCE STUDIES.** At this early stage of the process, we propose the following recommendations to improve design quality of Corps products.

a. The Interdisciplinary Planning Team (IDPT) should meet with the local sponsor. The purpose of this meeting is to get a first-hand account of the problem, to identify the scope of the study, and to clarify the sponsor's expectations. A local sponsor could be a port authority, levee, board, county, state, or other federal agency. *ER 1105-2-100*, paragraph 2.9 c3, states: "Early in the reconnaissance phase the District Commander shall coordinate with state and local officials to determine their involvement in the study and any interest in sponsoring the feasibility study. The district commander also will obtain, early in the reconnaissance phase, the potential sponsor's perception of the problems and opportunities; in particular, the issues that will affect the acceptability of any recommended solutions." Appropriate Engineering personnel should be invited to participate in this meeting.

b. Reconnaissance studies should have a senior level review that is conducted in a meeting format. Participants in this senior level review should include the Technical Chiefs of Hydraulics, Design, Geotech, Engineering, Planning, Construction, and Operations. It should be held early in the scoping process. *EC 1110-2-268*, paragraph 9a, states: "Engineering should assess potential alternatives to determine if they will function safely, reliably, efficiently, and economically. In addition, engineering, construction, and operations should jointly assess whether potential alternatives are practical to construct, operate, and maintain." Construction and Operations should be involved in the assessment of alternatives--this would result in improvements in constructibility and operability.

c. The complete reconnaissance document should be reviewed by the Engineering Division. This is a district product, and it should be reviewed by the district staff as a complete product. During the reconnaissance study, adequate time must be scheduled to accommodate this review.

d. The Initial Project Management Plan (IPMP) is a very important document because it is the basis for all the engineering and design costs and schedules for the feasibility report. Engineering should be provided adequate time to input into this IPMP. Reference *EC 1110-2-268*, paragraph 6b: ". . . Engineering effort for the reconnaissance phase consists of . . . and developing the engineering effort and budget required for the feasibility phase and IPMP." The IPMP contains the costs presented in the Feasibility Costs Sharing Agreement (FCSA). It is the basis for assigning tasks between the Corps and the sponsor and for establishing the value of in-kind services. Hastily prepared IPMP's with erroneous costs and schedules will be a certain embarrassment to the Corps of Engineers.

e. The Corps must be honest and up-front with the sponsor and must explain the risks. Projects with tight benefit-cost ratios may drop out during the feasibility study. The local sponsors are taking a risk because their share of the feasibility study costs may be lost if the project is not justified in the feasibility report.

f. Experienced engineers should be assigned to the team engineers who use good judgment and can see the big picture. *ER 1105-2-1100*, paragraph 2.9e2 states: "District Commanders will ensure that experienced and qualified personnel are assigned to the study team for the reconnaissance phase. Due to the short time available to conduct the study, many decisions will have to be based solely on professional judgment without all the desirable information available."

33. **FEASIBILITY REPORTS.** The following recommendations should help overall design and product quality in this phase.

a. Experienced engineers should be work on the feasibility reports. Reference *EC 1110-2-268*, paragraph 10: "The focus of engineering during the feasibility study is on establishment of project features and elements, developing design assumptions, assessment of available data, and collection of new data necessary to prepare an accurate baseline cost estimate for the project." Now that General Design Memoranda (GDM) have just about been eliminated, it is extremely important that the feasibility reports and Engineering Appendices clearly define the scope and cost of the project. Experienced, innovative, and competent engineers should be utilized on these reports.

b. All necessary field data, borings, and surveys should be obtained to estimate quantities and to do an adequate design. The design in this phase is the basis for the baseline cost estimate. *EC 1110-2-268*, paragraph 6c, states: ". . . Sufficient engineering and design are to be performed to enable further refinement of project features, prepare the baseline cost estimate, develop a design and construction schedule, allow design on the selected plan to begin immediately following receipt of PED funds, and allow the project to survive without need for reformulation, GDM, or post authorization changes." Failure to budget and schedule for the acquisition of field data during the feasibility phase will lead to inadequate baseline cost estimates and project schedules.

c. Communicate with the local sponsor during the process so that he is on board with the scope of the project. There should be no late surprises. Engineering should be included in the meetings with the local sponsor to ensure mutual understanding, between sponsor and designer, of the total project requirements.

d. The Project Management Plan (PMP) requires a considerable amount of input from Engineering. The total package should be reviewed by Engineering personnel and endorsed by the Chief of the Engineering Division. Reference *EC 1110-2-268*: "Engineering must prepare estimates of engineering and design funding requirements for all phases of the project in support of the PMP. . . . Engineering must also provide support to PM in developing revisions to the Project Management Plan for the selected plan."

e. Completed feasibility reports (the complete document) must be reviewed by Engineering personnel and signed by the Chief of the Engineering Division. Sufficient time must be scheduled for this review.

34. **DESIGN AFTER FEASIBILITY.** The following recommendations should help improve overall product quality in this phase.

a. The new Engineering Manuals (EM's) and technical guidance are sufficient for the designing districts to do quality design jobs. There is no need to change the design policy. (Reference *ER 1110-2-1150: Engineering After Feasibility*). This regulation outlines what is required in the various design documents. The districts should also seek and obtain advice from their division office or from HQ USACE when needed.

b. USACE needs to invest the necessary engineering and design effort in the design **prior** to the bid opening. The Corps should not fool itself into believing that it can cut corners during the design phase and expect to save costs. This "penny wise and pound foolish" mentality will most assuredly result in costly modifications and change orders during construction, and Engineering may spend more engineering and design funds during construction than were saved initially. A low up-front investment in engineering and design effort is sure to lead to more "firefighting" during construction.

c. Sharing of workload or design partnering between districts, divisions, headquarters, and organizational elements is essential for the Corps team to function efficiently. IPMP, PMP, TRC, etc. are focal points for reaching agreements.

d. Constructibility, bidability, and operability reviews and the independent technical review of the designs are extremely important to design quality and must be accomplished in a timely manner. Also, the local sponsor should be given the opportunity to review the design. Good reviews improve the quality of the final design.

e. Use reviews to develop junior engineers.

f. For all complex projects, Engineering considerations, which emphasize the make-or-break items of the plans and specifications that must be properly executed during construction, **should be written** for field personnel. These engineering considerations are needed to make quality projects.

g. Periodic visits to the field by the designers, designer involvement in resolving construction problems, and a lessons-learned feedback system are also key elements in the development of quality design products. Engineering divisions must allocate resources to accomplish these tasks. The ESSC Customer Survey cited *Lessons Learned* as an issue where Engineering Divisions must make significant improvements.

h. Use more standard feature designs utilizing the CADD system.

i. Engineers need training on CADD system

j. Several recommendations similar to the above were mentioned in the USACE *1982 Blue Ribbon Committee Report* on Engineering Divisions.[5]

35. **CONCLUSIONS.** The subgroup reviewed the procedures for project development from reconnaissance through construction. Many areas were identified where changes would improve the quality of projects. While the task force did not specifically address the Military project design and construction process, many of the principles identified for the Civil Works process would be applicable. The DQTF concluded that implementation of the TAQ/TQM principles and a dual-career track system would be most effective and complementary in accomplishing those improvements.

[5] *Maintaining Technical Engineering Capability in Engineering Divisions of the U.S. Army Corps of Engineers, Summary Report 82-505* (Engineering Division's Blue Ribbon Committee, 29 July 1982).

V. WORK FORCE ISSUES

36. **INTRODUCTION.** This section of the report focuses on work force issues (Subgroup D). The DQTF believes that producing **quality products** is primarily a function of the people who do the work. Although good management systems and practices in the Corps' district organizations are important, properly skilled and trained people are the key to success.

37. **IMPORTANCE OF HAVING EXPERIENCED DESIGNERS.** Technically complete products are not an accident. They require technical skills and experience across the work force. "Many excellent military and civil works structures have been designed using Corps in-house resources. Most often the design quality has been equal to or superior to that of the private sector. In many district offices the design capabilities and design quality continues to improve. However, in some districts there has been a noticeable downturn in the quality of the final design packages submitted to the division for review and approval."[6]

a. Experienced designers are of premium value throughout the USACE process, from initial project development and design through construction and operation. As Engineering Divisions lose experienced designers, there is a direct and negative impact on providing quality services and products to its internal customers (Construction, Planning, PPM, and Operations). Senior FTE's can be replaced by junior FTE's in a numerical sense, but the quality and proficiency of work will not be identical. Engineers with fewer than five years of experience require closer supervision, more training, and more intensive review to ensure that the technical work is well organized and executed and that technical errors and omissions have been detected and corrected. Less experienced engineers take longer to accomplish design than more senior engineers, and this adversely influences the schedule and budget components of product quality. Also, the less experienced engineers cannot independently provide the same degree of technical completeness as senior designers.

b. "The Corps places a lot of design responsibility on junior engineers. Junior engineers are defined as engineers with less than 5 years of design experience. Most junior engineers are well-educated and enthusiastic about their work. Good designs are produced when the efforts of the junior engineers are directed and coordinated by senior design Engineers. Poor designs almost always result when senior designers can not or will not on a regular basis take time to review and critique the design calculations and structural details prepared by junior engineers."[7] As time and cost pressures become more intense, this facet of junior engineer development can be curtailed in the short run.

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[6] Ralph Strom, *Structural Design Quality Within the Corps of Engineers* (Portland, Oregon, December 1991) (Annex B).
[7] *Ibid.*

c. Division-level reviewers of district products discovered design deficiencies in the Structural Engineering portion of projects. Some examples are listed below:

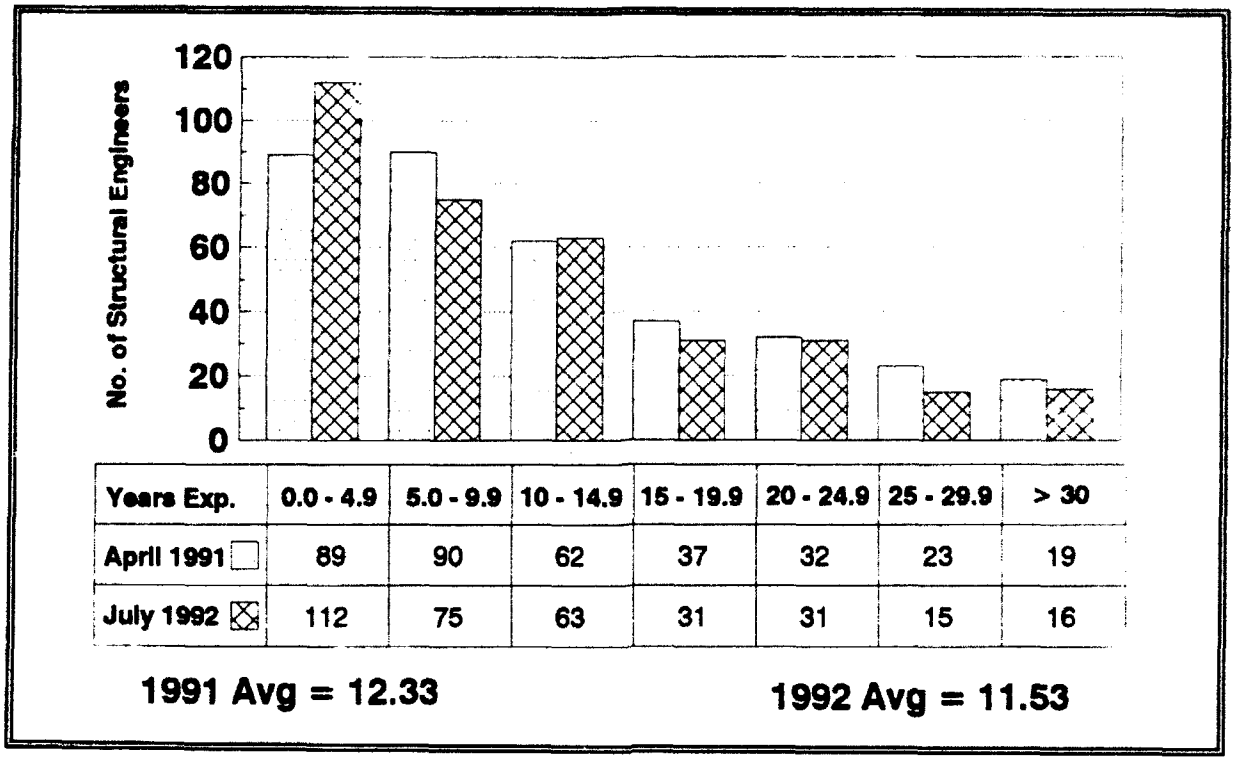
- Inadequate design coordination
- Improper structural idealization
- Inadequate regard for constructibility
- Improper emphasis placed on strength or serviceability
- Design responsibility shifted to the general contractor

Annex B contains a more detailed explanation of these deficiencies and how their presence degrades from a quality product. These examples were cited to demonstrate the amount of coordination and complexity associated with producing a technically complete and correct product. Similar examples could be cited for Hydraulics, Foundations, or other disciplines. The point is the same. Many of the design deficiencies can be attributed to a lack of attention by senior engineers to the work performed by junior engineers. Each, however, is related to one or more specific problems that surface during the final design reviews by the division. Discovering deficiencies at the final review stage results in delays, amendments, and political pressures that lead to "gut feeling" decisions rather than decisions based on comprehensive engineering analysis.

38. **LOSS OF TECHNICAL EXPERTISE.** Senior designers are the key to quality design. Design quality deteriorates when an organization loses design experience, especially at the first level of supervision. This is the current situation in USACE.

a. Senior designers continue to leave the USACE Engineering Divisions for more lucrative positions and promotional opportunities in project management, private industry, or other federal or local governmental agencies. The DQTF collected information on Structural Engineers in USACE and analyzed the years of USACE experience. Between April 1991 and July 1992, the average years of USACE experience dropped from 12.33 to 11.53. See **Figure 21** for a comparison of data for this 15-month period. In this short period of time, the Corps lost an average of almost 1 year of experience for its Structural Engineers.

b. This decrease was due to a combination of factors: transfers to higher graded positions in other functional offices, other governmental agencies, and private industry; freezes on hiring and high-grades; and uncertainty about the impacts of USACE reorganization. The collective experience of the DQTF indicates that this loss of experience is typical of other Corps engineering disciplines, that the demand for experienced design engineers will not decrease, and that this situation must be a major concern to the USACE senior leadership. It is imperative that we reverse this trend of losing technical expertise.



Years Exp.	0.0 - 4.9	5.0 - 9.9	10 - 14.9	15 - 19.9	20 - 24.9	25 - 29.9	> 30
April 1991	89	90	62	37	32	23	19
July 1992	112	75	63	31	31	15	16

Figure 21. YEARS OF EXPERIENCE IN USACE -- STRUCTURAL ENGINEERS

c. In addition to the factors mentioned above, the impact of the Federal Employee Retirement System (FERS) is beginning to show itself. FERS employees can come and go more easily than Civil Service Retirement System (CSRS) employees. Structural Engineers with more than 10 years of USACE service are CSRS employees. They, more than the FERS employees, are tied to staying with the Federal Government. As these people retire, the average years of USACE experience will continue to drop unless there are more incentives to keep the FERS engineers in the technical discipline.

39. **GENERAL COMMENTS FOR IMPROVEMENTS.** The project team--planners, project managers, and the various design disciplines within Engineering such as Architecture, Civil, Structural, Hydraulic, Geotech, Mechanical, and Electrical--must work together and closely coordinate their work. This takes skilled people who are willing to communicate on a one-to-one basis to solve their respective problems. Quality must be designed in the product--not reviewed in at a later date.

a. Project team members must have the necessary experience and skills to use their judgment and make good decisions. Early in the project--the reconnaissance and feasibility stages--an experienced Design and Planning team with good team skills will be able to weed through the many study alternatives rapidly and zero in on the most promising feasible plans. This will result in reduced costs for reconnaissance and feasibility studies and will reduce the time it takes to do them.

b. For this team to flourish, the functional branch chiefs within Engineering and Planning must control less and allow the Planning and Design team the freedom to use their judgment and make decisions during the course of design. This would include free and open discussions by all members of the Design team, resulting in a synergistic approach to the final design.

c. We need to develop specific training plans for providing upward mobility opportunities to district personnel who want to continue working as Design Engineers, but have a desire to advance themselves in their careers. These training plans can and should be tailored to meet the specific needs of the district.

d. If senior designers and the division gave more attention to review during the early design phases of the project, many of the problems cited in this report could be avoided. Periodic informal review sessions with division reviewers would be most helpful. These early meetings could be used to determine where expertise is lacking and where outside consultants services or the services of the division, HQUSACE, or Corps laboratories are needed.

e. Design engineers should be given the opportunity to visit projects in the construction phase to see first hand the impacts of their designs. These site visits should also give the designers an appreciation of the construction problems and should enable them to improve their future products.

f. Design Engineers should be encouraged to take developmental assignments in Construction and Operations Divisions. These assignments will not only make better designers out of the engineers when they return, but each organization will improve the understanding of one another. Communication between elements becomes better, and both organizations can become more effective in producing products.

g. USACE needs a system (like the one developed by DQTF for Structural Engineers) to track the experience and migration of technical personnel.

h. The Work Force subgroup identified the following problems in the Engineering Divisions of USACE:

- Turnover of designers adversely affects quality
- Recruitment/retention problems exist
- Careers/grades stagnate in the technical arena
- There is lack of training
- Site visits are insufficient

Over the next several meetings, this subgroup discussed and investigated these problem areas and essentially recommended two concepts to address them. These are a Dual-Career Track System and Design Partnering. The remainder of this section discusses these concepts and provides recommendations.

40. **DUAL-CAREER TRACK PROBLEM DESCRIPTION.** Traditionally, a successful professional career in the Corps of Engineers ultimately meant leaving the technical arena and moving into supervisory and managerial positions with higher grades and salary. Such a career path is certainly the desire of many Corps professionals; however, many prefer a career entirely on the technical track. A study by the Massachusetts Institute of Technology concluded that approximately 20 percent of engineers prefer the technical track. The desire to go into management peaks when the engineer is in his or her late 20's and declines steadily thereafter. Engineers who stay on the technical track realize the limits in grade and salary. These engineers then take one of the following paths:

- Leave for a higher paying technical position in private industry
- Reluctantly enter a management position later in their career for higher grade and salary
- Remain with Corps but possess decreased career-oriented motivations; have a greater desire for more interesting work, without regard to organizational standing

a. During the past several years the disparity between technical and management career opportunities has increased. For example, many of the project managers at the district level are at the GS/GM-13 level. The implementation of Project Management produced a migration of two kinds of engineers--1) those who desired to enter management ranks and 2) those who would have preferred to stay on the technical track, but realized the limited career progression available and, therefore, moved to PPM for a higher grade and salary.

b. To illustrate the disparity between career promotional opportunities in the technical and managerial paths, some real-life examples show the results of some individual decisions made by Corps engineers. The next three pages show the salary profiles in constant 1965 dollars for three sets of USACE employees.

(1) *Example 1.* In this example, both engineers graduated from the same university, have similar capabilities, and have worked in the same district for more than 30 years at high performance levels. The "Manager" has worked in Engineering, Planning, and Project Management. The "Structural Engineer" has stayed in the Structural Engineering section, is a senior designer, and has been a principal contributor to every major structural design project in the district. (See **Figure 22** for the variations in salary in constant 1965 dollars for each employee.)

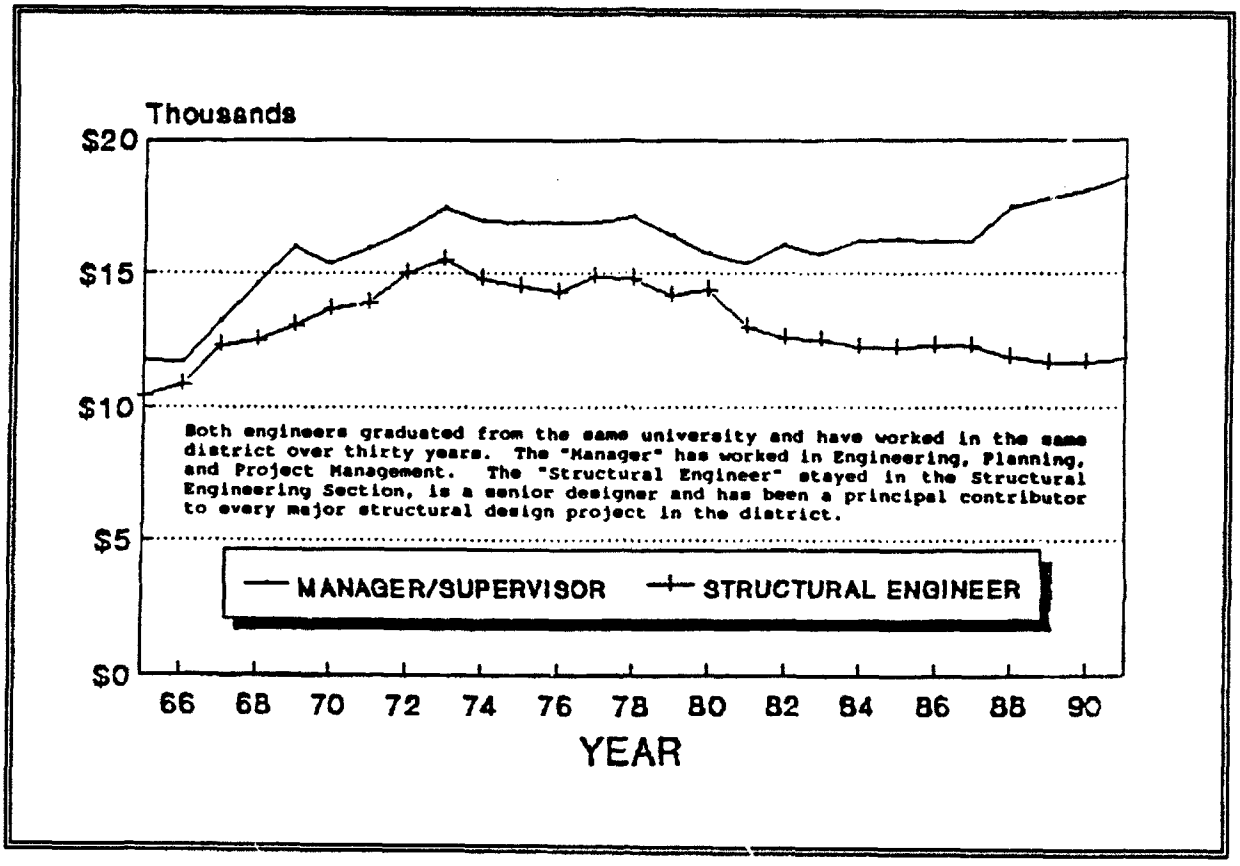


Figure 22. SALARY PROFILE (IN CONSTANT 1965 DOLLARS) -- EXAMPLE 1

(2) ***Example 2.*** Both engineers worked in the Huntsville Division as GS-13 Structural Engineers from 1968 to 1973. In 1973, the "Manager" became a project manager and the "Structural Engineer" decided to remain in the technical area and moved to an operating district where he finished his career with USACE. (See **Figure 23** for the salary variations for each employee in constant 1965 dollars.)

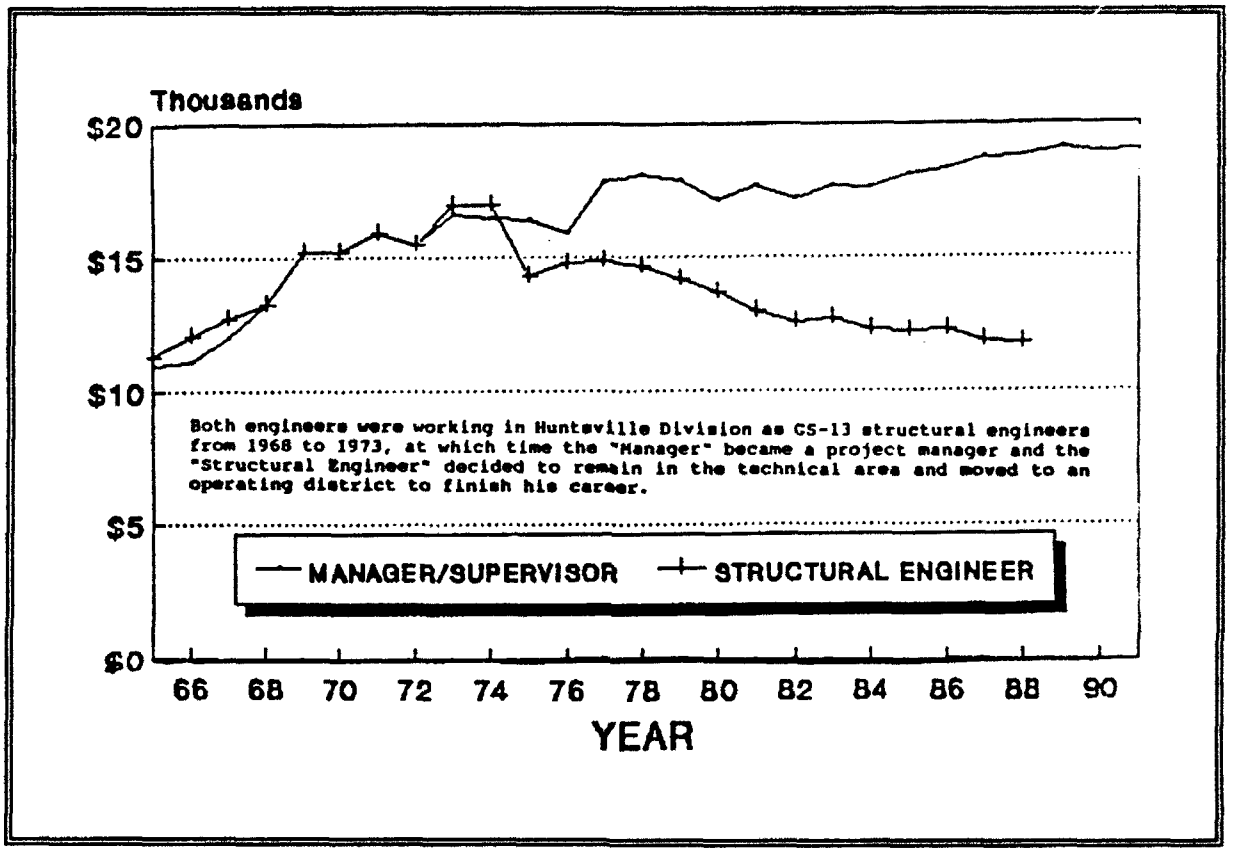


Figure 23. SALARY PROFILE (IN CONSTANT 1965 DOLLARS) -- EXAMPLE 2

(3) *Example 3.* Both engineers started their careers as geotechnical Design Engineers in the same district, at approximately the same time about 22 years ago. The "Manager" became a supervisor and pursued that career field, while the "Foundation Engineer" accepted a technical position at a division office and pursued that career path. (See **Figure 24** for the salary variations for each employee in constant 1965 dollars.)

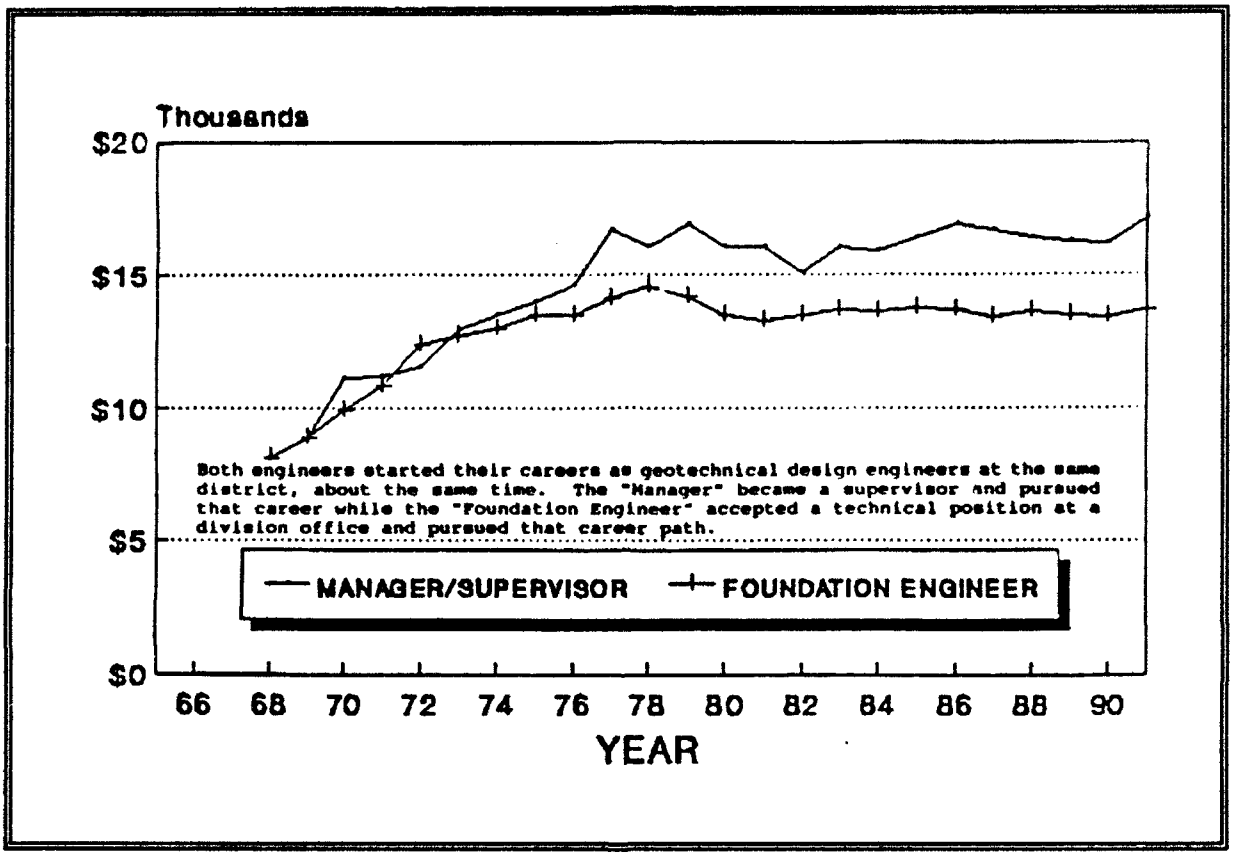


Figure 24. SALARY PROFILE (IN CONSTANT 1965 DOLLARS) -- EXAMPLE 3

c. In terms of constant 1965 dollars, USACE technical personnel who remain at the district level are paid at a rate barely above their entrance salary. Their salary is approximately 70 percent of the manager's salary. For the technical person who goes to a division office, the salary improves but still remains 10 to 15 percent below the manager's salary. The dual-career track has the potential for closing the salary gap between the manager and the technical person.

41. **DUAL-CAREER TRACK DISCUSSION.** This DQTF subgroup built upon the work of an earlier task force to frame its dual-career track discussion. The "Engineer and Scientists Dual-Career Track Implementation Plan," dated November 30, 1989, was the foundation for a USACE proposal to OPM for a demonstration project. That plan was the product of the Dual-Career Track Task Group (DCTTG) formed in the fall of 1988 by the Engineer and Scientist Career Planning Board. **Annex C** contains extracts from the DCTTG Report.

a. The Corps' reputation is based on superior technical and managerial expertise. When these factors are effectively combined, the result is a quality design--technically complete, on schedule, and within budget. Product quality is dependent on all of the Corps' experienced engineers, architects, scientists, and managers working together. However, those who choose technical careers are not afforded the same promotion and salary opportunities as those who choose the management track.

b. The current classification system recognizes specialized expertise within a specific discipline in certain circumstances where the function is not duplicated in any other office in the Corps of Engineers. For example, in one district that is designated as a technical design center for expansive soils, there is a GS-13 technical specialist for expansive soils. However, this is extremely limiting and does not recognize the Corps-wide need for experienced Design Engineers and does not address the retention and turnover problems previously described. When highly competent engineers reluctantly move from the technical arena into management because it is the only path to higher pay and status, the Corps suffers from loss of technical talent and from the inevitable discontent of those new managers. The Corps needs experienced engineers and scientists, who are creative and productive, to provide quality services to its customers. Dual-tracking is the solution.

c. A DCT system for FOA has been advocated since 1982. In 1987, the Corps' Leadership Enhancement and Development (LEAD) team recommended that a DCT system be instituted in the Corps and that the Career Planning Board should establish guidelines and a formal monitoring/counseling system. The LEAD team believed that the DCT system not only would encourage staff to attain increased levels of technical expertise but would increase the overall quality of the manager/leader pool. The DCT system is in full harmony with the implementation of Project Management as described in EC 5-1-58, dated 24 April 1992. The matrix described in the EC clearly defines the roles and responsibilities of each function. The HQ PM Steering Committee continues to develop generic job descriptions for the key functional positions of Project Manager and Technical Manager.

d. The DQTF predicts that if the grade structure for experienced engineers does not improve, Engineering will just be a training ground for young engineers. Young engineers will enter as interns, progress to the GS-11 or GS-12 level, and then, just as they are becoming most productive, are likely to move on for higher paying positions outside of the Engineering Division of the Corps. Product quality will suffer in the long run because the quality of the product is a function of the experience and the quality of the people doing the work.

42. **PROPOSED DUAL-CAREER TRACK SYSTEM FOR USACE.** The DCT should be operative for all of the Corps' Engineer and Scientist disciplines. Currently the Corps has a few GS-13 to GS-15 nonsupervisory positions in the Engineer and Scientist career field at divisions and headquarters. The proposed Corps DCT system will provide additional opportunities for

people to perform a broader range of technical functions by creating the potential for GS-13 to GS-15 nonsupervisory positions throughout the organization.

a. The DCT system will begin at GS-13 and will provide the careerist an opportunity to move to GS-15 in technical fields. Generally speaking, it will be most common to find GS-13 and GS-14 technical experts at district levels; however, it may be possible for GS-15 positions to be created at districts.

b. The 1988-89 proposal for DCT envisioned the following positions: **GS-13 Technical Expert I** who would be an expert on proven concepts and practices within his/her specialty area; **GS-14 Technical Expert II** who would conceive, plan, and conduct work in his/her specialty where there is little theory and/or accepted methods guiding application; and **GS-15 National Technical Expert** who would serve as the expert consultant for the technical specialty area.

c. This DQTF broadens the earlier definitions of technical experts and envisions the following:

(1) **Technical Expert IA** -- An interdisciplinary expert on nonstandard concepts and practices within his/her specialty areas. The expert will be able to adapt currently accepted practices to site specific conditions. The expert operates in an environment that requires flexibility, "speed," responsiveness, expeditious action, team work, and broad responsibility. The expert will advise leadership on their interdisciplinary specialty and will lead FOA committees concerned with their technical responsibility.

(2) **Technical Expert IIA** -- A multidisciplinary/functional expert who would move freely across boundaries between two or more Design disciplines (e.g., Structural-Soils, Hydraulic-Civil, Mechanical-Structural) or between technical functions (e.g., Engineering-Construction, Planning-Engineering, Programs/Project Management-Construction). With proven ability in multiple disciplines/functional areas, these individuals would be of greater value to the organization--they would make it possible to move rapidly and efficiently to plan/design small projects and to bring true integration of design/construction knowledge in evaluating/negotiating construction claims.

(3) **Technical Expert IIIA** -- A multiorganizational expert who would serve as a principal USACE expert on state-of-the-art engineering technology and current and potential applications to advanced engineering systems. Typically, these positions are filled with people who have proven ability and extensive experience in engineering and design of complex, one-of-a-kind projects. Their expertise is in demand by more than one district or division. These positions would encourage engineers and scientists to strive for engineering excellence in solving the complex problems of today and tomorrow.

43. **DUAL-CAREER TRACK BENEFITS**. The DCT system is intended to promote greater productivity and to retain Corps engineers and scientists through better morale and increased job satisfaction by broadening opportunities for career advancement. The DCT should make it easier to recruit and retain top engineer and scientist graduates. The DCT could contribute to the creation of a more streamlined organizational structure within the Corps. DCT systems also

create a number of benefits for organizations: expedited development of technical expertise; retention of valuable senior technical specialists; greater job satisfaction among technical employees because of equitable opportunities for advancement; and easier recruitment of technical personnel.

44. **DUAL-CAREER TRACK RECOMMENDATION.** Because the current system for promoting technically excellent individuals into the management chain is not working as well as it should, the DQTF fully supports and endorses the Corps' Dual-Career Track Office of Personnel Management (OPM) Demonstration Project proposal that was transmitted to the Army Deputy Chief of Staff for Personnel on 21 October 1991. That proposal reflects the Corps growing awareness that design experience, along with team and technical leadership, is required for effective and responsive service to internal and external customers. We need to develop an expanded technical engineering career path in addition to the current path leading to technical management. Currently, engineers who excel technically are often forced to choose supervisory or management positions if they want to advance in their careers. The dual-career ladder that allows promotion of individuals as technical experts must be strengthened, and managers must be encouraged to use it. This system, if effectively utilized, will permit young engineers and scientists in the organization to advance without joining management--it will permit them to continue to sharpen their technical skills and to advance up their technical career ladders at the same time. This system has long been effective in promoting technical excellence in USACE research laboratories. The same can occur in the districts and divisions. This is an indispensable system for assuring that the Corps of Engineers remains the world's top engineering organization.

Current Status: The USACE Human Resources Directorate has submitted the Dual-Career Track Demonstration Project proposal (with the definitions of "Technical Experts" used in **Annex C**) to OPM. The proposal has been briefed and as of January 1993, OPM staffers have reviewed the USACE proposal and are currently working with USACE to reach a common ground.

45. **DESIGN PARTNERING BACKGROUND.** In this era of radical changes in missions and shifting budgets, Corps' management is faced with severe problems of how to maintain its technical competence and how to manage the workload. Without technical competence, the Corps will become just another government procurement agency subject to all of the inadequacies and criticisms that have befallen so many of its sister agencies. The following thoughts and suggestions could become the basis for policy decisions that will assist Corps managers in maintaining the technical competence and stability of their work.

a. The Corps of Engineers presently is one of the largest, technically competent groups of architects, engineers, and scientists in the world. The Corps needs to recognize its technical strengths and capitalize on its geographic distribution of divisions, districts, and other technical centers such as laboratories. USACE laboratories should be seen as in-house partners. When a project is complex and requires state-of-the-art design or development of new methods or techniques, the laboratories should become members of the district team.

b. The Corps' technical competence is a national resource and asset that we, as managers, must maintain. We must focus our energies on the best utilization of Corps offices by stabilizing the workload and work force, and on achievement and maintenance of technical

excellence. Technically-capable and geographically-dispersed districts/technical centers allow USACE to respond to civil emergencies anywhere in the country.

c. Civil and Military program changes and year-to-year workload fluctuations are geographical and magnify the problems faced by division and district leaders in managing the costs of doing business, stabilizing overall personnel strengths, and maintaining technical competency. District workloads will never be balanced to personnel strengths within their Engineering organizations. While a district's overall manpower and work allotment may be balanced, the workload between technical disciplines will never be perfect (e.g., too many Geotechnical Engineers and not enough Hydraulic or Structural Engineers). Workload instability threatens the stability and quality of the Corps' technical work force.

46. **DESIGN PARTNERING--A PROPOSED SOLUTION.** Design Partnering is the cooperative execution of design work between USACE offices in order to provide customers with timely, affordable, high quality design products. Design partnering should not be confused with brokering. With design partnering, no missions, functions, or projects would be assigned across organizational boundaries. Rather, design partnering is the means of providing selected engineering support to a sister district's missions. Under a design partnering initiative, districts, which have work but are unable to provide enough manpower to respond to the particular demands of a project, will be assisted by other districts that have the required expertise and manpower in order to get products to USACE customers quickly. Corps experience has shown this to be effective. Division offices must assure that this occurs.

a. In order to deliver quality products to its customers, USACE needs to recognize the strengths and capabilities of each district. Sending design work to where the people are is easier and less expensive than sending people to where the design work happens to be this year, knowing that it will be somewhere else next year. Modern communications and computer linkages between Corps offices greatly facilitate the ability to effectively provide technical support for missions remote from where the engineering is accomplished. The Corps also needs to promote design partnering for better utilization of its engineers, architects, and scientists.

b. The best incentive for ensuring quality engineering is having one district do work for another through mutual agreement and desire to accept and give work through design partnering. This is peer judgment at its purest. The concept of quality and utilization of technical expertise is an incentive to share workloads. Design partnering offers tremendous flexibility, with respect to changes in funding, in schedules, and in project scope, while further developing technical capability.

c. The Corps places a premium on mobility of its employees. It encourages personal and professional development and career advancement through mobility. No argument is made regarding the value of mobility to the individual or the Corps. However, the Corps too often overlooks the value of employees who, for personal reasons, are not mobile or have elected to not be mobile. These are good and valuable employees who provide continuity within USACE district offices and represent the Corps well in their community through their long association with local social and professional organizations. USACE should recognize their value and should better utilize their abilities.

d. Design partnering is one of the best methods the Corps has for developing and maintaining design quality. USACE should develop a strong policy of design partnering because

it enhances technical competence; provides challenging work to Corps engineers; maintains viability of the districts; reduces costs; and enhances functional, aesthetic, and technical design quality of products.

e. **Proposed Design Partnering Policy Statement.** "It is the policy of the Corps to encourage design partnering between offices to enhance technical expertise and improve its ability to provide quality designs to customers on schedule and at reasonable cost."

47. **CONCLUSIONS.** Senior people are critical to producing quality products and projects. A **dual-career track system** will help keep senior people, and this will help to alleviate many of the problems described in the beginning of this section. **Design partnering** can provide challenging work for Corps employees, can help to resolve temporary workload imbalances, and can help to retain technical expertise.

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VI. RECOMMENDATIONS AND CONCLUSIONS

48. **INTRODUCTION.** The DQTF investigated a number of factors and has made several specific recommendations for improving quality in USACE. We concluded that there are many things that Engineering Divisions can, and must, do to work smarter and to correct the deficiencies cited by their internal customers. However, the divisions do need some help from HQUSACE management because most processes are now "interdependent." The other sections of this report presented recommendations on some specific and process-oriented items. We will not repeat all of the details here; rather we have chosen to combine all of the recommendations into four major groupings which require HQUSACE support.

49. **RECOMMENDATION #1 -- STRONGLY REINFORCE A COMMITMENT TO PROJECT QUALITY AND FUNCTIONAL PRODUCT QUALITY.** The DQTF recommends that the Chief of Engineers, as the corporate leader of USACE, reinforce his commitment to the quality of projects, which is the keystone to providing Corps customers with effective projects and services that meet all of their requirements and expectations. Quality design is the thread that runs through the fabric of all USACE technical products. Emphasizing technical quality may result not only in product improvements, but improvements in meeting project budget and schedule because better products cost less when they are done correctly the first time. A commitment to technical quality may help stem the loss of technical engineering expertise. If USACE doesn't produce quality projects, it will soon have no customers.

50. **RECOMMENDATION #2 -- DEVELOP AN ACTION PLAN TO ATTRACT AND RETAIN TECHNICAL EXPERTISE--ESTABLISH DUAL-CAREER TRACKS.** The DQTF recommends that USACE continue to pursue, and place a high priority on, attracting, developing, and retaining technical expertise. Implementation of a dual-career track system for the Engineer and Scientist Career Program (such as the Directorate of Human Resources proposal that has been forwarded to OPM) is a key element in achieving quality. The dual-career track should enable USACE to retain experts in positions where they provide the most value to the organization and enhance the Corps' ability to produce quality projects. This will permit technical experts to advance to higher grades in nonmanagerial or nonsupervisory positions. Technical experts are valuable to USACE for their ability to foresee problems, to recognize viable alternatives, to solve complex technical problems, to devise efficient technical solutions, to advise other technical personnel throughout USACE and the nation, to mentor and develop junior engineers, and to advance USACE state-of-the-art products. The dual-career track will help to retain technical expertise, which will be more critical in the future as the Corps moves to one level of technical review. (USACE reorganization into new, more robust technical centers should contribute significantly to enhancing the technical quality of the USACE work force that does planning and engineering.)

51. **RECOMMENDATION #3 -- EMPHASIZE PROJECT MANAGEMENT/TECHNICAL MANAGEMENT (PM/TM) TEAM ROLES AND RESPONSIBILITIES ACROSS USACE.** The DQTF recommends that USACE apply Total Army Quality/Total Quality Management (TAQ/TQM) principles to the business processes through the Project Management System.

Quality projects result from the performance of quality processes in all elements of an organization. PM emphasis is needed because Engineering Divisions, by themselves, cannot improve all of the processes and systems necessary to produce quality projects for USACE customers. The interdependencies between functions can best be integrated by a corporate quality management approach that is implemented by the District Engineer. Life-cycle accountability for time, cost, and technical quality is essential to ensure that the corporate focus is on the project rather than on the individual functional products. Applying TAQ/TQM will enable USACE to maintain its position of providing cost-effective solutions to the nation's engineering problems. The body of the report contains many procedural recommendations for improving performance in the Engineering Divisions. Listed below are some of these specifics:

- Institute TQM process in each district
  (this will improve internal communications)
- Set up a task force to examine the **small projects process**
  (in order to reduce time and costs)
- Drastically **reduce** reporting requirements
- Provide more technical engineering involvement/**funding up front**
  (in project definition and scope of work)
- Shift focus from design cost to **total project cost**
- Build **quality** into **design process**
  (rather than in review process)
- Improve **communications** with external partners
  (about the way USACE does business)
- Establish a **meaningful** performance measurement system
- Meet periodically to **share** organizational successes

52. **RECOMMENDATION #4 -- USE RESOURCES EFFECTIVELY THROUGH DESIGN PARTNERING.** The DQTF recommends that USACE encourage and actively support the practice of design partnering. Design partnering is not a brokering concept; it is a way to improve quality by matching unique technical capability with unpredictable workload. The cooperative execution of design work between offices will challenge the technical work force and will enhance USACE's ability to deliver timely, affordable, high quality projects to its customers. Design partnering capitalizes upon, and strengthens over time, the technical expertise of its design work force and embodies peer review. It is an easy method for assuring a healthy and viable engineering capability. Design partnering will work well with the current or reorganized USACE structure.

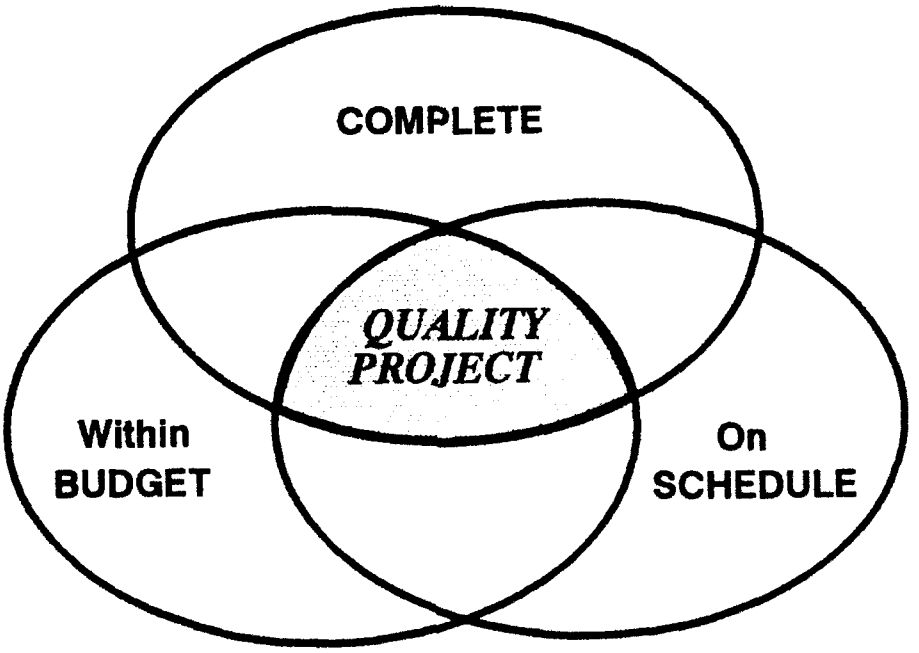
53. **CONCLUSIONS.** The Corps of Engineers faces a number of challenges:

- Developing and delivering **quality projects**
- Reducing the cost of doing business
- Maintaining technical competence

a. If USACE is to survive, all functional elements must make **quality** first. Quality is conformance to customer-generated and mutually-agreed-upon expectations and requirements. Prevention, not detection, of errors is where more attention must be focused. Experienced technical personnel must be retained in the Engineering Divisions and must make contributions (i.e., insightful designs) early on to save in overall project costs.

b. If **technical quality,** or **completeness**, does not become the organization's standard, employees will each develop their own standard, and "Schedule First, Cost Second, and Completeness Third" may become the norm once they see what happens to those who miss schedule or cost milestones. Only by maintaining the proper balance between the three competing elements will USACE be able to consistently deliver **quality projects** to its customers.

c. The Design Quality Task Force believes that the implementation of its recommendations will make USACE the technical organization of choice, the organization that can effectively and efficiently serve the nation now and into the twenty-first century. We want Corps customers and partners to equate USACE with **technically-complete** and **cost-effective** solutions to their problems.



USACE: **Excellent Projects on Time** and **within Budget**

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ANNEX A

MAINTAINING DESIGN QUALITY IN THE CORPS OF ENGINEERS

RAY NAVIDI
Chief, Design Branch
Huntington District, U.S. Army Corps of Engineers

ANNEX A

MAINTAINING DESIGN QUALITY IN THE CORPS OF ENGINEERS

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ABSTRACT

There is a concern among the technical staff that the Corps' design products in the future may be of lower quality than they have been to date. In preparation for this paper, a questionnaire on design quality was prepared and sent to the Chiefs of Structural Sections of the Corps Districts. Responses were received from not only the structural discipline, but also from the other disciplines within Engineering Division. Results of the questionnaire are tabulated in the paper along with a discussion of design quality in engineering.

INTRODUCTION

Changes within the past few years in the organization of the Corps of Engineers have had considerable impact on the agency's traditional way of planning, designing, and constructing the Civil Works projects. While these changes are aimed for completing projects on time and within budget, design quality, which has been the Corps' hallmark, seems to have been overlooked.

As a 17-year employee of the Corps who has a high regard for the organization and its accomplishments, the writer has been concerned about a gradual decline of emphasis on maintaining design quality in the Corps of Engineers. Informal discussions over the years with colleagues throughout the Corps have indicated that they, too, have the same concern. In preparation for this paper, a questionnaire on design quality was developed and sent to the Structural Chiefs of thirty-seven Corps Districts, which represent all Districts in CONUS. Inasmuch as the subject is not unique to the structural discipline, the addressees were asked to pass copies of the questionnaire along to the other design section chiefs in their offices.

The great response to the questionnaire (82 replies) reinforces the writer's perception that there is a genuine concern for quality among the technical staff of the Corps of Engineers. It is sincerely desired that the work done here can result in a positive influence for our future.

RESULTS OF THE QUESTIONNAIRE

Before discussing the results of the questionnaire (**Figure 1**), it is appropriate to say a few words about the make-up of the respondents. The majority of the replies are from people who are considered the "backbone" of the Corps' design work. As section Chiefs and senior technical experts, this group is responsible for assigning work to capable designers, applying sound engineering judgment, determining applicability of existing criteria and/or developing new ones, providing guidance and consultation, and assuring completeness and accuracy of design. As such, this group has the most direct and critical role in the success of the Corps' design mission and their opinion should be valued.

After tabulating the responses to the questionnaire, it can be readily observed that a less promising trend exists, and it would be less than sincere to downplay the significance of the situation. The majority of the respondents feel the Corps is producing above average quality products, which is an indication of their pride in the organization. However, over one-half of them say that there has been less emphasis on quality in recent years and that the trend for the production of Quality design is declining. In answer to the question of balance between quality and schedules, an overwhelming 83% say there is too much emphasis on schedules at the expense of quality.

The survey shows that most offices do not have sufficient resources for accomplishing quality work and that the present grade structure of the Corps' Districts is inadequate for retaining experienced designers (questions 7 and 13, Figure 1).

When one considers the above answers and the others listed in Figure 1, the message coming across is very clear: We have been able to do a good job so far, but unless more emphasis is placed on quality there will be problems. The Corps has not experienced a major problem to date, but the people who are responsible for its design mission are now raising the yellow flag. Considering the source, the importance of this message cannot be overemphasized.

WHY SHOULD THE CORPS BE CONCERNED ABOUT QUALITY?

Several years ago, it was determined that the Corps' projects from planning to construction took too long, and that accountability should be improved. A series of remedies aimed at improving the situation were put into motion by the then Assistant Secretary of the Army, Mr. Page. The crux of the changes, which everyone in the Corps is familiar with now, has to do with bringing the Corps more in line with the private sector. The impact of these changes will not be fully realized for a long time; however, the Corps is now more than ever conscious of the time and cost constraints.

Something that should have been considered was the differences between the nature of the Corps' business and that of the private sector. The Corps is the only nation-wide water resources agency, and there are no engineering firms in the country with such a diverse, complex, and intricate mission as the Corps' Civil Works program. The limitations that make the Corps projects take so long have not and will not change due to several constraints such as local sponsor's funding capability, real estate requirements, Federal funding and budget cycle, endless involvement and coordination with local, state, and various federal agencies, environmental concerns, etc. None of these activities can be easily compressed, and design is the only area over which the Corps has complete control of scheduling and can shorten its duration - an activity that is not part of the problem in the first place. It is not difficult to predict the outcome. Without sufficient time and with the pressure to get the job done on schedule and within budget, quality will have to take the back seat.

Unlike private industry, there are no indicators in the Federal Government to warn the management that the "company" is in trouble because of the poor quality of its products. When the auto industry started producing shoddy products several years ago, the consumers finally got fed up and stopped buying their products. When the profits started going down, management got

the message and started improving the quality of their cars and trucks, but not until they had lost a sizable share of the market to foreign car makers. In the case of Government agencies, how does upper management get the message about the quality of their products? After all, who is going to stop "buying" our products or return them under the "lemon law"?

In the service organizations of the Government, it may be understandable why there may be resistance to strive for quality and improved efficiency. It takes an overall organization commitment to achieve quality. This takes a tremendous amount of effort, dedication, and personal sacrifice. Considering the nonprofit nature of the Government and the lack of meaningful incentives for its employees, it is easy to see why quality is only given lip service. While the lack of quality in service organizations results only in inefficiency and poor productivity, consequences of poor quality in an engineering organization will eventually lead to damages beyond anyone's imagination. This is because the only time it is realized that a serious problem exists in an engineering organization is after a major failure or catastrophe has occurred, e.g., the Teton Dam failure and the Challenger disaster. It is not suggested in any way that such situations exist today in the Corps; there are too many higher level reviews for a total failure condition to go unnoticed. But, as meeting schedules and budget become the central focus of the organization and with dwindling design and design review resources, it may be just a matter of time before something falls through the crack.

QUALITY DESIGN IN THE CORPS

Quality is a long-term investment. It does not happen accidentally without agreeing to pay for it up front and waiting for the results to start paying off. It is, therefore, a commitment that must start from the top. It is only the top management who can set the tone by declaring total organizational commitment to quality and allocate necessary resources. The commitment must be genuine and supported by real action, for engineers are too intelligent to be fooled by slogans, fads, or another regulation which requires reporting about quality. Once engineers are convinced that quality is top priority with management, then it becomes a philosophy which will be embraced by everyone in the organization.

The production of quality design requires adequate time, clear guidelines, and experienced designers. This is a simple process if there are no constraints. However, it is recognized that in a real-world situation there are both internal and external limitations within which the Corps is operating. The sizeable and complex organization of the Corps, its design, review and submittal process, and the intricate nature of its design mission place quality, schedules, and budget on divergent and, sometimes, conflicting paths. The challenge to the management is to eliminate or minimize those constraints over which the Corps has control. If that is to happen, the engineers of the Corps believe that the organization is fully capable of preserving the quality of its design while remaining sensitive to time and budget constraints.

CONCLUSION

Responding to the water resources needs of the nation and providing total engineering support for the Army demands the highest degree of professionalism, dedication, and state-of-the-art engineering. This is not an easy assignment. It requires ingenuity and, sometimes, trial and error to obtain the best solution. The engineers in the Corps work on some of the most difficult and complex projects, some of which have not been designed or built before. The Corps has been successful in accomplishing its mission so far. It appears that there is now a concern among the technical staff that the quality of the Corps' products in the future may be in jeopardy.

The questionnaire highlights several factors and a number of constraints which either directly or indirectly impact quality. The current perception is that while there are less resources available for technical work, the Corps is devoting increasingly more resources to managing, monitoring and reporting the projects. The respondents also feel that there are too many layers in the organization and that there is too much demand on the technical staff to do more and more administrative work.

Fifty percent of the people polled believe the organization is top heavy with Project Managers, and they cite the low grade designers and the large number of support staff as detrimental to the Corps' mission.

A more detailed analysis of the situation and providing solutions for improvements or changes needed to assure quality in the Corps is beyond the scope of this paper. However, the vital importance of the subject warrants a comprehensive study of design quality in the Corps. In order to obtain an unbiased evaluation, it is recommended that the study be performed by an ad hoc committee under authority of the Commander, USACE. To assure the objectivity of this committee, the members should be comprised primarily of engineers in the grades 12 to 14 with direct design experience between 10 and 20 years. In view of the differences in the make-up of the Corps' Districts and Divisions, each office should be studied individually by means of on-site interviews with appropriate design personnel. The committee should be tasked to develop a report of its findings along with specific recommendations for improvements and/or changes needed. It is hoped that the results of this study will become the cornerstone of any future changes which may be occurring in the organization, and that they will contribute toward maintaining the Corps of Engineers' proud tradition of excellence.

1. How would you rate the overall quality of the Corps products?
   Poor - Average 29% Above Average 65% Excellent 6%

2. How do you see the trend for production of quality design in the future?
   Declining 53% No Change 27% Improving 20%

3. Do you feel there is an adequate balance between schedules and quality?
   Too Much Emphasis on Schedule 83%
   Adequate Balance 16%
   Too Much Emphasis on Quality 1%

4. Do you feel there has been a change in the emphasis on quality in recent years?
   Less Emphasis 54% No Change 28% More Emphasis 18%

5. Does your office have a workable design quality management plan?
   Yes 45% No 55%

6. How does the upper management in your District promote and/or assure quality?
   a. By including quality in the performance plan of employees 30%
   b. By means of informal discussions with subordinates 28%
   c. By enforcing a design quality management plan 19%
   d. No action 23%

7. Do you feel sufficient resources are provided for accomplishing quality work?
   Yes 40% No 60%

8. For the design of Civil Works Projects, how would you rate the quality of the work by A-E's as compared to the Corps'?
   Lower 71% Same 27% Higher 2%

9. How would you rate the experience of the District's technical staff?
   Scale: I(Poor) - 5(Highly)

	Average
a. Designers	3.82
b. Unit & Section Chiefs	3.95
c. Branch Chiefs	3.61
d. Division Chiefs	3.57

Figure 1. DESIGN QUALITY QUESTIONNAIRE (extracted from the paper "Maintaining Design Quality in the Corps of Engineers," July 1991)

10. What is the attitude of the District staff toward quality?

	Unconcerned	Fully Committed
a. Designers	3%	97%
b. Unit & Section Chiefs	5%	95%
c. Branch & Division Chiefs	30%	70%
d. Others (Specify) LCPM	84%	16%

11. How would you rate the motivation of the District's technical staff?)
Scale: I(Insufficient) - 3(Highly)

	Average
a. Designers	2.38
b. Supervisors	2.36
c. Branch & Division Chiefs	2.28

12. How would you rate the morale of the technical staff?
Scale: I(Very Low) - 4(Very High)

	Average
a. Designers	2.38
b. Unit & Section Chiefs	2.56
c. Branch & Division Chiefs	2.86

13. Do you feel the present grade structure of the District is adequate to retain experienced designers?
Inadequate 78% Adequate 22%

14. In the context of this subject, are there any constraints which impact your ability to produce quality work?
No 9%
Yes 91% -- 1. Time and funding; 2. Lack of resources;
3. Too much resources devoted to "managing" projects;
4. Too many layers; 5. Lack of priorities;
6. Too much demand on technical staff to do administrative work.

15. Is the organization of the Corps set up satisfactorily for producing quality design?
Yes 50%
No 50% -- 1. Top heavy with PM's; 2. Lower grade of designers;
3. Too many administrative and support staff.

Number of people polled = 82
Discipline (in descending order): Structural, Civil, General Engr, Mech, Elec, Architectural
Position (in descending order): Section Chief, Supervisory Design Engineer, Chief & Assistant Chief of Branch, Assistant Chief of Engineering

Figure 1. DESIGN QUALITY QUESTIONNAIRE (continued)

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ANNEX B

STRUCTURAL DESIGN QUALITY WITHIN THE CORPS OF ENGINEERS

RALPH STROM
North Pacific Division, Portland
U.S. Army Corps of Engineers

(TQM/TQA) principles to the business processes through the Project Management System.

ANNEX B

STRUCTURAL DESIGN QUALITY WITHIN THE CORPS OF ENGINEERS

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GENERAL

Many excellent military and civil works structures have been designed using Corps in-house resources. Most often the design quality has been equal to or superior to that of the private sector. In many district offices the design capabilities and design quality continues to improve. However, in some districts there has been a noticeable downturn in the quality of the final design packages submitted for Division review and approval.

THE IN-HOUSE DESIGN TEAM

The Corps places a lot of design responsibility on junior engineers. Junior engineers being defined as engineers with less than 5 years design experience. Most junior engineers are well educated and enthusiastic about their work. Good designs are produced when the efforts of the junior engineers are directed and coordinated by senior design engineers. Poor designs almost always result when senior designers can not or will not on a regular basis take time to review and critique the design calculations and structural details prepared by junior engineers.

PROBLEM

Unfortunately many senior designers have deserted ranks for more lucrative positions and promotional opportunities in project management. Few remain loyal to design technology because of the great deal of time and effort required to keep abreast of building code changes, new computer applications, research and development, etc. Senior designers are the key to quality design. Many of the design deficiencies cited in the following paragraphs can be attributed to a lack of attention by senior engineers to the work performed by junior engineers. These design deficiencies have been grouped into the following categories:

- Inadequate design coordination.
- Improper structural idealization.
- Inadequate regard for constructibility.
- Improper emphasis placed on strength or serviceability.
- Design responsibility shifted to the General Contractor.

Each design deficiency will be described in general terms. Each, however, is related to one or more specific problems surfacing during the final design reviews by the Division. Discovering deficiencies at the final review stage results in delays, amendments, and political pressures which lead to "gut feel" decisions rather than decision based on comprehensive engineering analysis.

INADEQUATE DESIGN COORDINATION

Many projects designed by the Corps are large, requiring the design effort of many structural engineers. Different structures are usually designed by different engineers and often a single large structure may have different engineers working on different elements of the structure. On large projects a coordinated design effort is paramount. Lack of coordination has resulted in:

- Different designers selecting different safety factors and load combinations for use in design related to the same structure.

- Designers not properly accounting for the reactions from members designed by someone else.

- Different structural details for similar structural features such as for corbels, connections, beams, columns, etc.

- Different specifications for materials resulting in different strengths for similar structural members or connections.

- Using connection mechanisms that have vastly different rigidities in combination.

IMPROPER STRUCTURAL IDEALIZATION

Selection of proper load paths and failure mechanisms for structural idealization is important and somewhat difficult when soil structure interaction is involved. Loads will distribute to members in accordance with their relative stiffness and arbitrary assumptions on relative stiffness often leads to erroneous results. Selection of improper load paths and failure mechanisms for use in the design of structural components can lead to unacceptable distortions and cracking in ancillary structural elements at service load conditions. Examples of improper structure idealization discovered during final review include:

- Lateral loads distributed equally amongst free standing piles of differing lateral stiffness.

- Arbitrary soil pressure distributions assumed for pile and anchored wall systems without regard for the stiffness of the pile or wall relative to the soil.

- Tie back anchor systems in concrete that could not develop loads without unacceptably large displacements occurring in ancillary structural features and the surrounding rock foundation.

- Failure to consider all appropriate design load conditions or combinations.

- Arbitrary end restraint conditions assumed on elements of continuous members without consideration for moment redistribution.

- Selection of improper analysis method - Use of 2-D analysis techniques overlooking the third dimensional effect.

- Use of moment frame for lateral load resistance without isolating the frame from stiffer non structural components.

- Failure to consider all loadings and reactions necessary for equilibrium.

INADEQUATE CONSIDERATION FOR CONSTRUCTIBILITY

Reinforced concrete hydraulic structures are usually massive and heavily reinforced to support loads and to control cracking due to volume change effects. The layers of heavy reinforcement often compete for space with waterstops, piping, and various steel embedments. Careful detailing is required to eliminate all interference problems. Designers often do not recognize that contract specifications permit variances in dimensions and location. These tolerances need to be considered during the detailing and design phases. Examples of lack of consideration for constructibility include:

- Pile spacing that is too close and could result in interference problems even if placement meets construction tolerances.

- Rebar congestion at wall/floor joints such that there is insufficient space for waterstops.

- Rebar hooked in tight areas where space is insufficient and incompatible with minimum bend radius.

- Failure to use standard "proven" details that are constructible.

- Failure to consider the need and costs of temporary systems required for construction.

- Failure to consider construction loadings.

- Improper coordination with other disciplines concerning the use of common space, especially mechanical duct work and mechanical openings, during structural design and detailing.

- Use of proprietary products when common standards (ASTM, AASHTO, etc.) would work.

- Large size rebar bundled without consideration for space required for lap splicing.

IMPROPER EMPHASIS PLACED ON STRENGTH OR SERVICEABILITY

Engineers often feel that as far as concrete compressive strength is concerned, stronger is better. In massive reinforced concrete structures the additional concrete strength does almost nothing to improve moment capacity and very little to improve shear capacity. The higher strength concrete means higher cement contents and the greater likelihood of cracking due to volume change effects. On the other hand, often too stringent deflection requirements are set requiring massive sections to provide the needed stiffness to keep deflections within prescribed limits. Examples of improper emphasis on strength and serviceability include:

- High strength concrete selected by structural designers when it is not needed for strength. As a result costly construction temperature control are measures subsequently required to minimize cracking.

- High strength quenched and tempered steel selected when there is no practical way to preheat and control cooling during construction. Preheating and controlled cooling is essential during welding operations to maintain strength properties and prevent cracking in the heat affected zone.

- Unreasonable deflection limits established prior to design resulting in massive and costly reinforced concrete elements.

- Unreasonably high safety factors selected for low probability events resulting in an impractical and costly structure.

- Rebar bundled to increase member strength without consideration for the serviceability problems associated with additional cracking that occurs in the concrete surrounding the rebar.

- Failure to recognize special tolerance needs for unusual situations resulting in serviceability problems (deflections) such as can occur with cantilevers and long spans.

- Failure to consider drainage requirements for floor slabs, roof, and pavements.

DESIGN RESPONSIBILITY SHIFTED TO THE GENERAL CONTRACTOR

There has been a trend lately to place the design responsibility for various structural features of projects on the construction contractor. This practice can be unfair to the contractor, irresponsible on the part of the Corps, and costly. Reducing Corps design costs in this manner should be discouraged since it usually does not reduce project construction costs and results in claims when ever the Corps is not satisfied with the contractor's design solution. In some cases critical design aspects have been turned over to the contractor, and instances are known where during 8A set aside negotiations critical design elements of the project were changed to reduce costs without consulting the designer.

RECOMMENDATIONS

Many of the problems cited in this report could be avoided if more review attention by senior designers and the Division were concentrated at the early design phases of the project. Informal review sessions on a periodic basis with Division structural engineers would be most helpful. These early meetings could be used to determine where expertise is lacking and where outside consultants services or the services of Division, HQUSACE, or Corps laboratories are needed.

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ANNEX C

EXTRACTS FROM THE 1988 DUAL CAREER TRACK TASK GROUP REPORT

ANNEX C

EXTRACTS FROM THE 1988 DUAL CAREER TRACK TASK GROUP REPORT

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FOREWORD

The Dual Career Track Task Group was formed by the Corps' Engineer and Scientists' Career Planning Board in the Fall of 1988. Its charter was to develop a plan for implementing a Dual Career Track (DCT) within the Corps. This report constitutes the Task Group's recommendations for implementing this system in the Corps.

The Task Group is composed of Mr. Jack Niemi, Deputy District Engineer for Project Management, St. Louis District, Chair; Mr. Carl Enson, Chief, Engineering Division, Los Angeles District; Dr. James Johnson, Chief, Planning Division, Baltimore District; Mr. Thomas Leicht, Structural Engineering, St. Louis District; Mr. Robert Post, Chief Engineering Division, St. Paul District; Ms. Janet Ulivi, Structural Engineer, St. Louis District; and Mr. Jaman Vithalani, Chief Engineering Division, Wilmington District. Dr. Mark Dunning of the Engineer Institute for Water Resources provided research and report writing services to the Task Group. Mr. Wayne Kesler of HQ, USACE Personnel also provided valuable personnel clarification expertise to assist the Task Group's deliberations.

BACKGROUND

A DCT system for FOAs has been advocated for some time. In 1982, the Blue Ribbon Panel on *Maintaining Technical Capability in the Corps* expressed concern about recruiting, and keeping a highly qualified work force. A survey of the Corps engineers and scientists work force commissioned for this effort found that almost one-half of the Corps' engineers and scientists felt dissatisfied with the current career system and felt the system was ineffective for career planning decisions. Sixty-two percent of the field engineers and scientists work force agreed that the establishment of a separate career ladder for technical specialists would have very positive results in enhancing technical capability (Corps of Engineers, 1982). Consequently, the Blue Ribbon panel recommended that a DCT system be instituted as one means of making the Corps more competitive in attracting and maintaining a highly technically qualified work force (Corps of Engineers, 1982).

In 1987, the Corps' LEAD Team recommended that a DCT system be instituted in the Corps, noting that the Career Planning Board should establish guidelines and a formal monitoring/counseling system (Corps of Engineers, 1987). The LEAD team believed that the DCT system would not only encourage staff to attain increased levels of technical expertise, but would increase the overall quality of the manager/leader pool. The DCT system would increase morale for all concerned by providing for equal opportunity, earnings and recognition to both managers and professional technicians. By increasing opportunities for staff in technical positions there would be greater assurance that only those people who truly aspire to manage will seek those positions.

USE

DCT systems have been widely used in industry, and in government (see, for example, U.S. Department of Energy). They are principally used in research and development settings; however, they can also be found in other career areas such as law, marketing, manufacturing, sales, accounting, and personnel.

The DCT is generally formalized into parallel hierarchies; one providing a managerial career path, and the other providing advancement as a professional or technical expert. After occupying one or more entry level and journeyman positions, employees who are interested in achieving higher positions then select either a technical or management career development path. Each track contains positions which successively increase in responsibility and influence.

As noted previously, DCT systems have been found to create a number of benefits for organizations. Studies indicate that DCTs facilitate the development of technical expertise (Grass, 1979); opportunities are increased for the advancement of technical employees (Buckles, et al, 1984); and that technical employees generally have greater job satisfaction when they perceive that the DCT system provides equitable opportunities for advancement (Wolff, 1979; Raelin, 1987). In addition, DCT systems have been found to be an aid in recruiting because they demonstrate that the organization is committed to technical employee career advancement (Wolff, 1979).

LESSONS LEARNED

Dual career track Programs should be clearly defined and documented in terms of Performance standards, qualification criteria and accountability for the various ladder positions. This can only be accomplished if management is fully committed to supporting the dual career track program. In addition, the career paths must be truly achievable, rather than just diagrams on paper., before professionals will fully accept the program as a legitimate means of advancement (Sacco, et al., 1983; Cantrall, 1977; Roth, 1982). One way to achieve this goal is to provide high level professionals on the technical ladder with opportunities for active involvement in top management corporate decision making (at least in matters concerning technical areas). Through this active involvement, the professional track can be kept in the mainstream of the organization and the legitimacy of the program maintained (Buckles, et al., 1984; Raelin, 1987; Sacco, et al., 1983; Cantrall, 1977).

A DCT system needs to have a formal evaluation and selection procedure for filling technical expert positions. A formal, technical, review committee is often created to oversee the DCT program's screening, review and promotion process, and to assure standards of good quality. By using a committee to administer the program, the organization avoids perceptions of unfairness and arbitrariness that can arise when one person is in charge (Wolff, 1979). Criteria for admission to professional ladder rungs should be as rigorous as criteria for the managerial ladder (Raelin, 1987; Sacco, et al., 1983; Cantrall, 1977). In particular, care must be taken to avoid the actual or perceived use of higher graded technical positions as a "dumping ground" for incompetent managers or technical professionals whose chief qualification is longevity. Performance appraisals should be tailored to evaluate individual contributions and performance rather than factors such as length of service (Federal Highway Administration, 1988).

Salaries, benefits, status and responsibilities must be commensurate with each particular level of a ladder and, in addition, should be equivalent between both sides of the ladder, (technical and managerial), at each level. Care must be taken not to overemphasize the managerial side of the ladder. Promotions should be based on carefully defined criteria representing excellence in the respective discipline (Wolff, 1979; Cantrall, 1977; Raelin, 1987). In other words, promotions and rewards should be meaningful and appealing to the specific group they are meant for, as well as equitable among the various ladders. Organizational recognition of outstanding performance must also stretch beyond monetary promotions. Rewards for technical professionals should also encompass non-cash forms of recognition (e.g., larger office, secretarial support, autonomy or control over assignments) in order to make this side of the ladder more comparable with these typically managerial forms of recognition (Raelin, 1987). Similarly, the organization should provide for and encourage professionals to maintain contact with their outside professional associations in order to aid them in keeping abreast with advances in their chosen fields (Grass, 1979).

The DCT system should be actively promoted and clearly communicated to employees and prospective recruits. A description of the program should be made available to everyone within the organization (Wolff, 1979). In addition, the utilization of counseling and conflict management techniques can help to reduce the stress and conflicts which often accompany the introduction of a new system (Wolff, 1979; Raelin, 1987; Sacco, et al., 1983). If properly promoted, the DCT program can provide a formalized way of communicating management expectations to the employee regarding training, education, and work experiences that are required for advancement (Federal Highway Administration, 1988).

EXISTING TECHNICAL POSITIONS

The Corps already has some GS-13-15 nonsupervisory positions in the Engineer and Scientist career field. An inspection of District nonsupervisory positions showed that many of the positions are part of an emerging Life Cycle Project Management organization. Nonsupervisory positions at Divisions and Headquarters are, generally speaking, those of a technical review function. The proposed Corps' DCT will provide additional opportunities to perform a broader range of technical function by creating the potential for GS-13-15 positions throughout the organization. The proposed DCT structure is described in the next section.

DUAL-CAREER TRACK SYSTEM

The DCT will be operative for all Corps' engineer and scientist disciplines. The DCT system will begin at the GS-13 level, and will provide the careerist an opportunity to move to GS-15 levels in technical fields. While generally speaking, it will be most common to find GS-13 and 14 technical experts at District levels, it is also possible for GS-15 positions to be created at Districts as well.

GS-13 - Technical Expert I. The Technical Expert I is expert on proven concepts and practices within his/her specialty area. The expert will be able to adapt current accepted practices to the exigencies of particular situations following standard procedures and proven practice. The Technical Expert I pursues and correlates several lines of investigation within the generally known and accepted body of theory and method in the technical specialty area to develop new approaches for solving complex technical problems.

The Technical Expert I will participate in FOA executive deliberations involving their specialty area, and will advise leadership on their technical specialty. They will serve on FOA committees concerned with their technical specialty area.

GS-14 - Technical Expert II. The Technical Expert II conceives, plans and conducts work in his/her specialty where there is little theory and/or accepted methods guiding application: The Technical Expert II's depth and breadth of experience is such that he/she can be called upon to be a roving consultant to the entire Corps for advice in the specialty.

The Technical Expert II will participate in corps executive deliberations involving their specialty area, and will advise Corps leadership on their technical specialty. They will serve on Corps committees concerned with their technical specialty area.

GS-15 - National Technical Expert. Serves as the expert consultant for the technical specialty area. Develops and furnishes technical guidance and information to top level administrative and technical agency personnel, as well as other government agencies. Serves on interagency panels which are concerned with the technical specialty area.

INTENDED RESULT

The DCT system is intended to promote greater productivity, morale and job satisfaction among Corps scientists and engineers by broadening opportunities for career advancement. It achieves these results by providing enhanced opportunities for advancement for its technically oriented engineers and scientists, and by creating positions which offer a greater level of technical challenge for such individuals. Numerous studies have shown that among the most important motivational factors for engineers and scientists are the opportunities to engage in technically challenging work, and the opportunity to have autonomy in performing it (see, for example, Badawy, 1978; Delmar, 1979). The DCT system will create the types of positions which offer engineers and scientists such opportunities. Thus, by providing the opportunity for advancement, coupled with the opportunity for pursuing greater technical challenge, and having greater autonomy in doing such work, the DCT makes it much more likely that the best engineers and scientists will chose to remain with the Corps, and that they will continue to develop in their technical capability as well.

Similarly, the DCT should make it easier to recruit and retain top engineer and scientist graduates. A recent report in the Civil Engineering newsletter indicated that the Corps is the first employer of choice for graduating Civil Engineers. However, most such graduates career plans call for only a few years with the Corps before they move out to the private sector. The presence of DCT and the opportunities for advancement and technical challenge that it provides, could attract the best graduating engineers and scientists, and would certainly contribute to the retention of such individuals once they have joined the Corps.

The DCT is likely to create a number of other effects on the Corps. First, it is likely that the DCT will initially result in a somewhat higher average grade level in FOAs as new, higher graded technical expert positions are created. Such an increase is not likely to be large, because it is not likely that the numbers of technical expert positions created in an FOA will be large. This slight anticipated increase in grade level is likely to be a small price to pay for the large anticipated benefits described above.

A second potential effect of the DCT system is that it could contribute to the creation of a more streamlined organizational structure within the Corps. That is, by providing an alternate path for highly qualified engineers and scientists, the DCT may reduce a tendency to create sections within FOAs to support higher grades for such individuals. This effect would have an offsetting influence on average grade increase related to creating technical expert positions and could result in reducing the cost of doing business.

SUMMARY

This report has described the DCT system being recommended to the Career Planning Board. The system establishes an alternate career path for technically oriented engineers and scientists in Corps FOAS. This career path is tied to, and is consistent with, Federal classification requirements, and reflects lessons learned gleaned from research on other DCT systems.

The DCT system creates three new technical expert rungs or position categories - GS-13, Technical Expert I; GS-14, Technical Expert II; and GS-15, National Technical Expert. In order to create such positions, FOAs must first demonstrate that a need for a particular technical specialty exists. Peer panels are used to evaluate the technical qualifications of applicants for the positions. Finally, a Technical Expert Register is to be created to facilitate brokering of technical experts across FOAS.

Selection procedures for filling technical expert positions are compatible with existing practices. General documentation requirements are likewise compatible with SKAP. The DCT system will be integrated into ACTEDS. This may require some adjustment to ACTEDS to specify the type of training and development assignments needed to prepare individuals for technical expert positions.

The DCT system is intended to enhance the Corps' ability to attract and retain highly technical qualified engineers and scientists, and to enable the organization to keep abreast of rapid technological change. In order to ensure that the system achieves its goals, it is recommended that a committee be formed to monitor the implementation of the system during its first several years of operation, and to make refinements to the system that might prove necessary.

LAST PAGE OF ANNEX C